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NEW NORTHERNMOST RECORD OF THE BLUNTHEAD PUFFERFISH, *SPHOEROIDES PACHYGASTER* (OSTEICHTHYES: TETRAODONTIDAE) IN THE MEDITERRANEAN SEA

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ABSTRACT

A specimen of blunthead pufferfish Sphoeroides pachygaster *(Müller & Troschel, 1848) was caught in waters off Piran on 22 November 2012. This record represents the first catch in Slovenian waters and the northernmost occurrence of this species in the Adriatic and the Mediterranean Sea, as well. The blunthead pufferfish began its rapid spread from the east Atlantic towards the Mediterranean in 1979 reaching its northernmost extent in the northern Adriatic Sea thirty years later.*

Key words: blunthead pufferfish, *Sphoeroides pachygaster,* northern spread, Adriatic Sea

NUOVA SEGNALAZIONE A NORD DEL PESCE PALLA LISCIO, *SPHOEROIDES PACHYGASTER* (OSTEICHTHYES: TETRAODONTIDAE), NEL MARE MEDITERRANEO

SINTESI

Un esemplare di pesce palla liscio, Sphoeroides pachygaster *(Müller & Troschel, 1848), è stato catturato nelle acque al largo di Pirano, il 22 novembre 2012. Si tratta della prima cattura di tale specie in mare sloveno e della sua segnalazione più settentrionale nell'Adriatico e nel Mediterraneo. Il pesce palla liscio si sta velocemente espandendo dall'Atlantico orientale al Mediterraneo dal 1979, raggiungendo la sua massima estensione a nord, nell'Adriatico settentrionale, trent'anni più tardi.*

Parole chiave: pesce palla liscio, *Sphoeroides pachygaster,* espansione settentrionale, mare Adriatico

INTRODUCTION

Mediterranean fish fauna has faced many changes over the last decades. Many fish species were recorded for the first time in the Mediterranean Sea after the opening of the Suez Canal in 1865 while other newcomers arrived through the Gibraltar Strait. Some authors have considered the Mediterranean Sea to be one of the main hotspots of marine bioinvasion on the planet (Quignard & Tomasini, 2000).

The continuous arrival of new species has also been confirmed, although to a much lesser extent, in the Adriatic Sea (see for example Dulčić *et al*., 2003; Lipej & Dulčić, 2004; Dragičević & Dulčić, 2010; Dulčić & Dragičević, 2011). During the same period, native fish fauna experienced some changes as well. Some thermophilous southern species extended their area of distribution to the north. The northward spread of southern species is caused by the ongoing phenomenon of global warming (Francour *et al.,* 1994; Massutí *et al*., 2010).

The aim of this paper is to describe a specimen of blunthead pufferfish *Sphoeroides pachygaster* (Müller & Troschel, 1848) from the Gulf of Trieste in order to provide an overview of species spatial distribution in the Mediterranean and Adriatic Seas and analyze the spread of the blunthead pufferfish in both areas. The species is circumglobally distributed in the temperate and tropical Atlantic, in the Indian Ocean, in waters off Japan and the Hawaiian archipelago (Tortonese, 1986) and in the seas off Australia and New Zealand (Hardy, 1981). It is also present in the Mediterranean Sea; however the number of reports of this species is still rather low.

MATERIAL AND METHODS

The specimen of the blunthead pufferfish (Fig. 1) was caught in waters 5 nm west of Piran (45°35'43 N, 13°29'01 E) on 22 November 2012. It was caught from the muddy bottom at 22 m of depth. It was readily identified as the blunthead pufferfish (Müller & Troschel, 1848) according to the identification key of Tortonese (1986). It was accurately measured to the nearest millimetre and weighed to the nearest gram. All measurements (according to Jardas, 1996) and meristic counts are presented in Table 1. The specimen is housed in the ichthyological collection of the Marine Biology Station (National Institute of Biology) in Piran.

Fig. 1: Blunthead pufferfish** (Sphoeroides pachygaster) **caught in waters off Piran in November 2012 (Photo: B. Mavrič).
Sl. 1: Riba napihovalka** Sphoeroides pachygaster**, ujeta v vodah pri Piranu novembra 2012 (Foto: B. Mavrič)

In order to understand the phenomenon of the blunthead pufferfish spread to the northernmost area of the Adriatic Sea and in the Mediterranean Sea as well, all available literature records of this species in the Mediterranean Sea and the adjacent eastern Atlantic were gathered. On the basis of more than 100 records (from 69 reported sources; see Appendix I) of the blunthead pufferfish in the eastern Atlantic and in the Mediterranean Sea we produced a map of the area with all records presented (Fig. 2). In many sources catchment locations were only approximately defined *e.g.* Sicily channel, Sušac Island *etc*. In those cases the coordinates have been chosen either within the centre of the area or territory or randomly near the territory. Although the data contain measurement errors in terms of coordinates, these errors are not problematic in this particular study of the wide area spread of the blunthead pufferfish. Another important consideration regarding the data set, when studying spatial distributions and their evolution over time, is that multiple records are reported at the same location in different time periods. This could mean that the species had settled down and is constantly present in the area. Using such data in the process of modelling leads to an inclusion of uncertainty in the data and produces errors in prediction location/trends (more in Gabrosek & Cressie, 2002). To deal with this problem a raster grid with cell size 0.5 degree latitude/longitude was created in ArcGis 9.3 and overlaid on sample data. If a single cell occupied more than one catchment location, the minimum value (year of the first record in the area) was assigned to the cell. For each single raster cell the centroid with minimum value as an attribute was extracted. The transformed dataset, year of first records within the 0.5 degree grid, were used in further analysis. This procedure has also positively influenced the effect of preferential sampling, since for the areas with dense concentrated samplings only one value was assigned, making a sample more evenly distributed in the whole area. A drawback of such a procedure is that the data on species spatial density were partially lost (32% of the original records were lost mostly in the area of high records density).

Our aim was to seek indices that could help us reveal the spatial pattern of the blunthead pufferfish population and its change over time. A good index for detecting change in spatial distribution over time is a distributional centroid and the variance of spatial distribution (Hollowed, 1992). The standard deviation ellipse is one of the tools incorporated in Esri ArcMap 9.3 software and has been used to demonstrate shifts in spatial

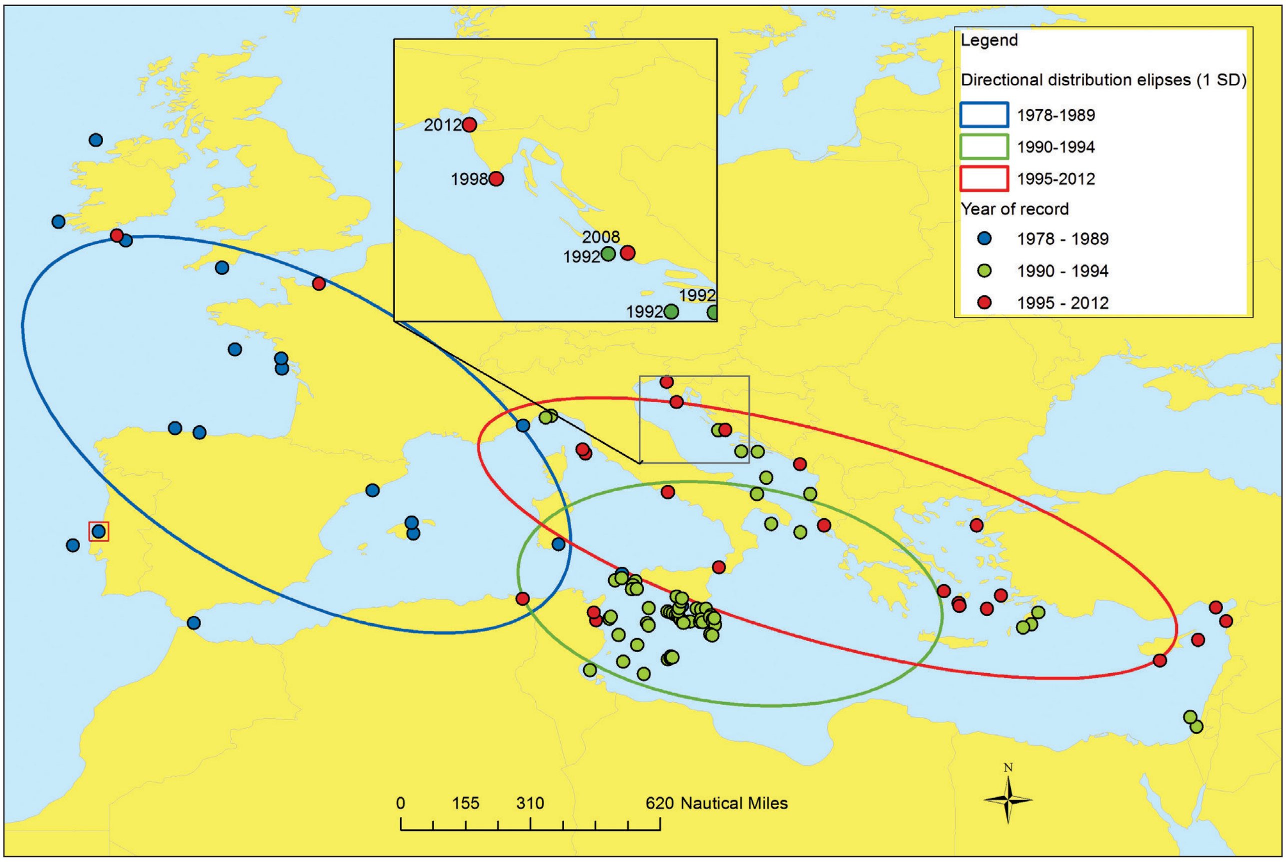

Fig. 2: Records of the blunthead pufferfish** (S. pachygaster) **in the Mediterranean Sea and eastern North Atlantic. The three directional distribution ellipses, calculated for three different time periods, indicate the shift in spatial distribution in time. The red square represents the first record off the European Atlantic coast.
Sl. 2: Zapisi o pojavljanju ribe napihovalke** S. pachygaster **v vzhodnem Atlantiku in Sredozemlju. Tri elipse, izračunane za tri različna časovna obdobja, kažejo prostorsko smer širjenja v posameznih obdobjih. Rdeči kvadrat prikazuje prvi zapis ob atlantski obali Evrope.

distribution over time. Spatial autocorrelation, within the entire study area, was tested using Global Morans I statistics (Anselin, 1995). In order to get a better insight into how local variations are clustered, Getis-Ord Gi statistics were also calculated (Getis & Ord, 1992). Getis-Ord Gi statistics (hereafter called Ord Gi) indicate, for any given location, how individual location is associated with the values of surrounding locations. Ord Gi statistics calculate standardized Z scores for any single location. High negative or positive Z scores indicate statistically significant spatial clustering formed by low or high values (Getis Ord, 1992; Ord & Getis, 1995). Absolute values higher than 1.96 are statistically significant for spatial clustering at the 0.05 level. Values around zero indicate that no apparent spatial clustering exists (neighbours in the selected area have almost random values). The ESDA (Explanatory Spatial Data Analysis) was carried out using GeoDa ver.0.95 (Anselin, 1995). All the parameters that have been used to demonstrate spatial spreading were calculated either in Esri ArcGis 9.3 or in GeoDa.

RESULTS AND DISCUSSION

Description and identification

All measurements and meristic counts are presented in Table 1. The studied specimen is among the biggest pufferfish caught in the Adriatic Sea to date, second only to the specimen, caught off Montenegro in 2008 (Joksimović & Mandić, 2008), which measured 450 mm in total length (Tab. 2). The specimen was identified by its typical stout and inflatable body with rounded snout, big head and skin without scales. In the mouth four large teeth (two in each jaw) form a beak. Eyes are rather big and oval in shape. A small dorsal fin is placed above the anal fin of similar size and shape. The caudal fin is slightly concave. The pelvic fin is absent. The body has smooth skin, without any scales, prickles or spines (as typical for the other species of this genus, recently confirmed in the Mediterranean Sea, namely *Sphoeroides marmoratus*). The colour of the dorsal surface and the flanks is greyish to olive green with many pale dots. The

Tab. 1: Morphometric data and meristic characters of the blunthead pufferfish specimen caught in waters off Piran in November 2012.
Tab. 1: Morfometrični in meristični podatki o primerku napihovalke, ujete novembra 2012 v vodah pri Piranu

Morphometric parameter	**mm**	**% of Total length**
Total length	348	100
Standard length	300	86.21
Head length	99	28.45
Head height	72	20.69
Head width	77	22.13
Eye horizontal diameter	23	6.61
Eye vertical diameter	16	4.60
Interorbital space	38	10.92
Snout length	49	14.08
Postorbital length	34	9.77
Width of peduncle	49	14.08
Width of gill opening	15	4.31
Predorsal length	220	63.22
Preanal length	232	66.67
Dorsal fin length	35	10.06
Dorsal fin base length	16	4.60
Anal fin length	37	10.63
Anal fin base length	15	4.31
Pectoral fin length	39	11.21
Caudal fin length	40	11.49
Body thickness	93	26.72
Body height	93	26.72
Internarial space	30	8.62
Meristic counts		
Dorsal fin rays	8	
Anal fin rays	8	
Pectoral fin rays	14	
Caudal fin rays	10	

ventral side is whitish. The meristic counts and morphometric data agree well with previously published data on the Mediterranean Sea (for example Dulčić, 2002).

Records of *S. pachygaster* in Mediterranean

Among the newcomers in the Mediterranean and the Adriatic Seas, the blunthead pufferfish deserved appropriate scientific attention over the last decades, beginning with its first Mediterranean appearance in 1979 in waters off the Balearic Islands (Oliver, 1981) (Fig.2 and Appendix I). After that time many records from various areas of the western Mediterranean Sea were published (see Dulčić, 2002 for site locations). This circumglobal temperate and tropical species rapidly dispersed throughout the Mediterranean Sea (Ragonese *et al.,* 1997) and it is considered as rather common in the western basin and in certain areas of the eastern basin (Golani *et al.*, 2002). In the eastern Mediterranean, the species was first reported by Golani (1996), who mentions a specimen collected by a trawl off Ashdod (Israel) in 1991 (Golani, 1996). In the eastern Mediterranean Sea the species was also recorded off Cyprus (Katsanevakis *et al.*, 2009), Turkey (Eryilmaz *et al.,* 2003; Bilecenoglu, 2010) and Greece (Zachariou-Mamallinga & Corsini, 1994; Peristeraki *et al.*, 2006).

The species is now considered as established in Greek waters (Zenetos *et al.*, 2007) and waters off Malta (Schiberras & Schembri, 2006). After the first record of the blunthead pufferfish in the Ionian basin in 1991 (Tur-

si *et al.*, 1992), this species showed a significant increase in abundance with time and there is now a steady population with the presence of spawning females (Maiorano *et al.*, 2010).

According to Ragonese *et al.* (1992, 1997) the area between Sicily and Malta hosts an established population of the blunthead pufferfish. Ragonese *et al.* (1997) reported that 403 specimens of *S. pachygaster* were collected in the Sicily Strait in the period 1990-1994. Orsi Relini (2010) supposed that such a number of pufferfish probably arrived in the Sicily Strait before the date of the first record in the Mediterranean in the eighties (Oliver, 1981). In fact the area could probably be considered as a centre from which the population is spreading in different directions. However, nowadays, according to the data obtained by experimental surveys, the population in the waters of southern Sicily (and probably in the channel, too) is rather small (Ragonese & Murara, 2012).

Blunthead pufferfish in Adriatic waters

The first records of this species date from 1992 when Bello (1993) reported the occurrence of this species in southern Adriatic waters, in waters off Albania and close to Mola di Bari (Fig. 2). At about the same time Jardas & Pallaoro (1996) reported records of many blunthead pufferfish in 3 different localities in the southern part of the Adriatic Sea: the Island of Sušac (altogether 3 records with 5 specimens), Glavat (single record with 3 specimens) and Blitvenica (1 record with 1 specimen) (Jardas & Pallaoro, 1996). The previous northernmost extension of the range of the species was close to the very tip of the Istrian Penninsula – Cape Kamenjak (northern Adriatic Sea), when a specimen of blunthead pufferfish was captured on 8 November 1998 (Dulčić, 2002). The studied specimen from the waters off Piran represents the northernmost record of this species in the Adriatic and Mediterranean Sea, as well (Fig. 2).

In the Adriatic Sea three species of the family Tetraodontidae have been recorded to date (Tab. 2). In addition to the blunthead pufferfish, the other two species are *Lagocephalus lagocephalus* and *L. sceleratus*. The first is a Mediterranean species and it was first reported in the Adriatic Sea by Dulčić at Molunat in 2004 (Dulčić & Pallaoro, 2006). The second species is a Lessepsian migrant, which is rapidly spreading throughout the eastern Mediterranean and to other areas. The first record of this species is from November 2012, when a specimen was caught in waters off Dubrovnik (HINA, 2012).

Dispersal of *S. pachygaster* into the Mediterranean

There are two main hypotheses regarding the presence of the blunthead pufferfish in the Mediterranean Sea. The first deals with the recent immigration of the puffer-

Tab. 2: Records of pufferfish species in the Adriatic Sea. Legend: Cro – Croatia, Ita – Italy, Alb – Albania, Mtg – Montenegro, Slo – Slovenia.
Tab. 2: Zapisi o pojavljanju različnih vrst rib napihovalk v Jadranskem morju. Legenda: Cro – Hrvaška, Ita – Italija, Alb – Albanija, Mtg – Črna gora, Slo – Slovenija

Species	Locality	Country	Date	n	Depth (m)	TL (mm)	Source
Sphoeroides pachygaster	Sušac Island	Cro	16.3.1992	1			Jardas & Pallaoro, 1996
S. pachygaster	Sušac Island	Cro	11.4.1992	2		101, 120	Jardas & Pallaoro, 1996
S. pachygaster	Sušac Island	Cro	April 1992	2			Jardas & Pallaoro, 1996
S. pachygaster	Glavat Islet	Cro	August 1992	3	120	147	Jardas & Pallaoro, 1996
S. pachygaster	Blitvenica	Cro	15.11.1992	1	130-150	213	Jardas & Pallaoro, 1996
S. pachygaster	Mola di Bari	Ita	1992	some			Bello, 1993
S. pachygaster	S Adriatic Sea	Ita	1992	many	30-130		Bello, 1993
S. pachygaster	Albania	Alb	1992	1	85		Bello, 1993
S. pachygaster	Kamenjak (Pula)	Cro	8.11.1998	1	125	45	Dulčić, 2002
S. pachygaster	Budva	Mtg	5.1.2008	1	80	450	Joksimović & Mandić, 2008
S. pachygaster	Šibenik	Cro	20.12.2008	1			Grubač, 2008
S. pachygaster	Piran	Slo	Nov 2012	1	20	348	This work
Lagocephalus lagocephalus	Molunat	Cro	2004	1	70	181	Dulčić & Pallaoro, 2006
L. sceleratus	Off Dubrovnik	Cro	Nov 2012	1		660	HINA, 2012

fish into the Mediterranean Sea from the Atlantic Ocean due to the gradual warming of the Mediterranean Sea. In fact the first records of this species originated only at the beginning of the eighties of the last century (Oliver, 1981). The second hypothesis is based on a painting by an Italian illustrator in 1558 in which the depicted fish could be identified as the blunthead pufferfish (Relini & Orsi Relini, 1995). The fish specimen, which was used as the model for the illustration came from the Delta of the Nile. Relini & Orsi Relini (1995) suggest that this fish was possibly present in the southern Mediterranean since ancient times. Obviously, since the opening of the Suez Canal was two centuries later, the blunthead pufferfish could not be related to Lessepsian migration.

Quéro *et al*. (1998) studied the phenomenon of the occurrence of tropical fish species along the eastern Atlantic coast of Europe. According to their results there is a clearly visible trend of the spread of the blunthead pufferfish towards northern regions (from latitudes 40° to 55°) over the time period 1975-1995. These data clearly favour the first hypothesis of the recent immigration, related to water warming, into the Mediterranean Sea.

Many studies have confirmed that one of the main ecological parameters known to affect fish population is temperature (*sensu* Francour *et al*., 1994; Dulčić *et al*., 1999). Many thermophilous species of southern Mediterranean origin have been recently recorded in the Gulf of Trieste, such as *Plectorhinchus mediterraneus* (Lipej *et al*., 1996), *Mola mola* and *Ranzania laevis, Luvarus imperialis* and others (Lipej *et al*., 2007). Some alien fish species originating from the Indian Ocean were also reported, such as *Siganus luridus* (Poloniato *et al*., 2010) and *Terapon theraps* (Lipej *et al*., 2008).

The blunthead pufferfish is listed as a vulnerable species in the IUCN (Roberts, 1996); however its placement in this category probably needs a revision based on updated records. On the basis of available data we produced a map of the area with all records presented (Fig. 2). We tried to analyse the change in spatial pattern and its evolution over time in the Mediterranean Sea. For this purpose the reduced dataset were used, and year of first record within the 0.5 degree lat/long grid were analysed. For the whole study area the results indicate a statistically significant high clustering of the data and weak spa-

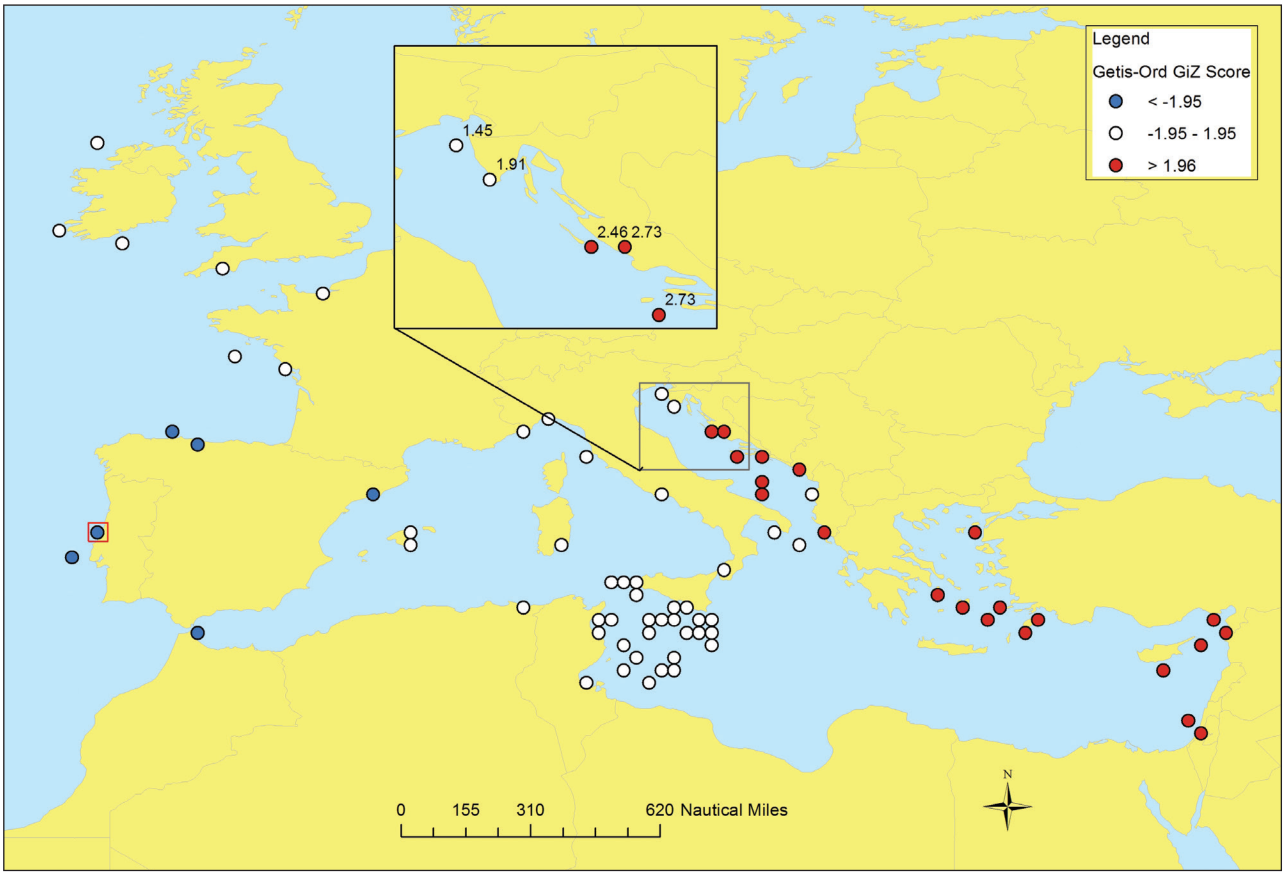

Fig. 3: Getis – Ord Gi Z scores indicating areas with significant spatial clustering of the first records in 0.5 degree lat/long greed. The red square represents the first record off the Atlantic coast of Europe.
Sl. 3: Getis – Ord Gi Z vrednost prikazuje statistično značilno gručanje prvih zapisov v 0,5-stopinjski mreži. Rdeči kvadrat označuje prvi zapis ob atlantski obali Evrope.

tial global autocorrelation (Morans I = 0.33, z = 3.61). Spatial autocorrelation occurs when the values of variables recorded at nearby locations are not independent from each other *i.e.* when adjacent geographic locations have very similar values (year of first records within the 0.5 degree grid in our case). Weak global spatial autocorrelation for the entire study area was expected and confirm the change in the spatial pattern of puffer fish records over time. It is common that the magnitude of spatial autocorrelation varies according to locations on a regional scale and exhibits significant clustering on a local scale. At local scale, Ord Gi statistics, with the search threshold for neighbours within 300 km, indicated few areas with statistically significant clustering. Figure 3 provides an overview of the calculated GiZ scores. As one can observe, high positive GiZ scores are clustered in the Adriatic, Aegean and Ionian Seas, indicating the directions of spread over the last two decades from the Sicily Channel (cluster with near zero values where the species had settled down and is constantly present over time). High negative values at the Atlantic coast of Europe and in the western Mediterranean represent the statistically significant cluster of earlier records and the direction of spread in the first decade after the very first record in 1978. It is quite evident that there is a clear eastward and northward spread of the blunthead pufferfish. Similarly, temporal dynamics can be observed from Figure 2. The three directional distribution ellipses, calculated for three different time periods, also indicate the expected spatial trend in time. As it is clearly evident from Figures 2 and 3 the donor centre of spread has its origin in the Sicily Channel where the great majority of all findings of the blunthead puffer were recorded.

According to the available data many trends of the northward extension of the blunthead pufferfish can be seen. The rather evident trend of spread along the western coast of Europe and northward to Great Britain and Ireland has already been described by Quéro *et al*. (1998).

In the Mediterranean Sea there are evident spread patterns in a north-easterly direction in the western Mediterranean, along the Levantine coast, in the Aegean Sea and finally in the Adriatic Sea, as well.

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APPENDIX 1: Records of blunthead pufferfish in the eastern North Atlantic and the Mediterranean Sea Legend: Country: Por – Portugal, Esp – Spain, Ire – Ireland, Ita – Italy, GBr – Great Britain, Fra – France, Isr – Israel, Cro – Croatia, Mal – Malta, Gre – Greece, Alb – Albania, Tun – Tunisia, Alg – Algeria, Mtg – Montenegro, Slo – Slovenia, Cyp – Cyprus, Tur – Turkey. Region: ATL – Atlantic, W – West Mediterranean, e – east Mediterranean, c – central Mediterranean.
DODATEK 1: Pojavljanje ribe napihovalke v vzhodnem severnem Atlantiku in Sredozemskem morju. Legenda: Država – Por – Portugalska, Esp – Španija, Ire – Irska, Ita – Italija, GBr – Velika Britanija, Fra – Francija, Isr – Izrael, Cro – Hrvaška, Mal – Malta, Gre – Grčija, Alb – Albanija, Tun – Tunizija, Alg – Alžirija, Mtg – Črna gora, Slo – Slovenija, Cyp – Ciper, Tur – Turčija. Regija – ATL – Atlantik, W – zahodno Sredozemlje, e – vzhodno Sredozemlje, c – osrednje Sredozemlje

N	Locus	Country	Region	Date	n	Source
1	Estuary of the river Tago	Por	ATL	Jun 1931	1	Gonçalves, 1941
2	Nazaré'	Por	ATL	May 1978	1	Calvário *et al*., 1980
3	Sintra, 34 Nm NW of Cap Roca	Por	ATL	Jun 1979	1	Calvário *et al.*, 1980
4	Ribadesella	Esp	ATL	25.2.1980	1	Ortea *et al*., 1981
5	Cala Ratjada, Mallorca	Esp	W	1979	1	Oliver, 1981
6	Bay de Donegal	Ire	ATL	Jan 1984	1	Wheeler & van Oijen, 1985
7	Comarca del Garraf, Catalunya	Esp	w	1984	1	Cerro & Portas, 1984
8	Sicilian Channel	Ita	w	1985	2	Vacchi & Cau, 1985
9	Cala Ratjada, Mallorca	Esp	w	1984	1	Moreno & Roca, 1984
10	SW Spain Almeria	Esp	w	1986	2	Crespo *et al.*, 1986
11	Gibraltar, Ceuta	Esp	w	1986	3	Crespo *et al.*, 1986
12	Gulf of Cagliari, Sardinia	Ita	w	1986	5	Vacchi & Cau, 1986
13	San Remo	Ita	w	1986	1	Barletta & Torchio, 1986
14	Plymouth	GBr	ATL	1.2.1987	1	Quigley& Flannery, 1992
15	NW Sicilia	Ita	w	Jul 1988	1	Arculeo *et al.*, 1994
16	Northern Spain	Esp	ATL	22.11.1988	1	Quéro *et al.*, 1997
17	sud Gascogne	Esp	ATL	21.12.1988	1	Quéro *et al*., 1997
18	Lorient	Fra	ATL	2.5.1989	1	Quéro *et al.*, 1997
19	La Rochelle	Fra	ATL	29.5.1989	1	Quéro *et al.*, 1997
20	Concarneau	Fra	ATL	25.8.1989	1	Quéro *et al.*, 1997
21	SW Ireland	Ire	ATL	19.8.1989	1	Quigley, 2002
22	Dingle Bay SW Ireland	Ire	ATL	18.10.1989	1	Quigley, 2002
23	Alboran Sea	Esp	w	12.6.1905	?	Camiñas *et al*., 1990
24	Imperia	Ita	w	1990	1	Fiorentino & Zamboni, 1990
25	coast of Israel	Isr	e	1990	1	Golani, 1996
26	Amendolara, Gulf of Taranto	Ita	c	1991	1	Tursi *et al.*, 1992
27	Ashdod	Isr	e	1991	1	Psomadakis *et al.*, 2006
28	Mola di Bari	Ita	a	1992	some	Bello, 1993
29	south Adriatic sea	Ita	a	1992	many	Bello, 1993
30	Gallipoli, Apulia	Ita	c	May 1992	1	Matarrese *et al.*, 1996
31	Sušac Island	Cro	a	11.4.1992	5	Jardas & Pallaoro, 1996
32	islet Glavat	Cro	a	22.8.1992	3	Jardas & Pallaoro, 1996

33	Blitvenica	Cro	a	15.11.1992	1	Jardas & Pallaoro, 1996
34	Ligurian sea	Ita	w	1992	?	Ragonese *et al*., 1992
35	Malta	Mal	c	1992	2	Ragonese *et al.*, 1992
36	Lindos, Rodos	Gre	e	23.11.1992	1	Zachariou-Mamallinga & Corsini, 1994
37	Plimmiri, south of Lindos	Gre	e	24.11.1992	4	Zachariou-Mamallinga & Corsini, 1994
38	Lindos, Rodos	Gre	e	Mar 1993	10	Zachariou-Mamallinga & Corsini, 1994
39	Gulf of Gabes	Tun	c	1993	1	Bradai *et al*., 1993
40	Albania	Alb	a	1993	1	Bello, 1993
41	Malta	Mal	c	1994	x	Schiberras & Schembri, 2006
42	Gulf de Lion	Fra	w	14.6.1995	1	Quignard & Raibaut, 1993
43	Strait of Sicily	Ita	w	1990-1994	403	Ragonese *et al*., 1997
44	Elba	Ita	w	8.8.1996	1	Bedini, 1998
45	cape Kamenjak, Istra	Cro	a	8.11.1998	1	Dulčić, 2002
46	Saros bay TR	Tur	e	Oct 1999	1	Eryilmaz *et al.*, 2003
47	Serifos Island	Gre	e	2000	1	Zenetos *et al*., 2007
48	South of Meganissi Island	Gre	e	2000	?	Zenetos *et al*., 2007
49	Bozcaada Island	Tur	e	May 2001	1	Eryilmaz *et al*., 2003
50	SW Ireland	Ire	ATL	1.1.2002	1	Quigley, 2002
51	SE Sikinos	Gre	e	26.8.2003	1	Peristeraki *et al.*, 2006
52	North of Lefkas Island	Gre	e	2004	?	Zenetos *et al.*, 2007
53	North of Lefkas Island	Gre	e	2005	?	Zenetos *et al.*, 2007
54	SE Serifos	Gre	e	14.6.2005	1	Peristeraki *et al.*, 2006
55	Cyprus	Cyp	e	2005	1	Katsanevakis *et al.*,2009
56	SE Sikinos	Gre	e	12.6.2005	2	Peristeraki *et al.*, 2006
57	Elba	Ita	w	Aug 2005	?	Ligas *et al.*, 2006, 2007
58	SW Leros	Gre	e	4.7.2006	1	Peristeraki *et al.*, 2006
59	Serifos	Gre	e	Oct 2005	2	Zenetos *et al*., 2007
60	SW Astypalaia	Gre	e	11.7.2006	1	Peristeraki *et al.*, 2006
61	Annaba	Alg	w	2008	1	Hemida *et al.*, 2009
62	off Budva	Mtg	a	5.1.2008	1	Joksimović & Mandić, 2008
63	N of Corfu	Gre	e	16.3.2009	1	lianaskerkyra.blogspot.com/2009/03/strange-fish-in-corfu-waters.html
64	Tyrrhenian sea	Ita	w	2008-2009	1	Guerriero *et al.*, 2010
65	Gulf of Hammamet	Tun	c	2009	2	Chérif *et al.*, 2010
66	Karatasas coast, Iskenderun Bay	Tur	e	26.10.2010	1	Eleftheriou *et al.*, 2011
67	Samandag, Iskenderun Bay	Tur	e	28.10.2010	1	Eleftheriou *et al.*, 2011
68	Strait of Messina	Ita	w	Mar 2012	1	Giordano *et al.*, 2012
69	Piran	Slo	a	Nov 2012	1	This paper

NOVI NAJSEVERNEJŠI ZAPIS O POJAVLJANJU RIBE NAPIHOVALKE, *SPHOEROIDES PACHYGASTER* (OSTEICHTHYES: TETRAODONTIDAE) V SREDOZEMSKEM MORJU

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POVZETEK

Primerek ribe napihovalke vrste Sphoeroides pachygaster *(Müller & Troschel, 1848) je bil ujet v vodah pred Piranom 22. novembra 2012. Gre za prvi zapis o pojavljanju te ribe v slovenskih vodah, obenem pa tudi za najsevernejši zapis o pojavljanju te vrste tako v Jadranskem kot tudi v Sredozemskem morju. Intenzivnejše pojavljanje te vrste v Sredozemskem morju se je začelo leta 1979 po prihodu iz Atlantskega oceana, trideset let kasneje pa se je napihovalka pojavila v najsevernejšemu predelu Sredozemskega morja. V prispevku avtorji na podlagi zbranih razpoložljivih podatkov o pojavljanju ribe napihovalke razpravljajo o širjenju areala te vrste v smeri proti vzhodu in severu.*

Ključne besede: riba napihovalka, *Sphoeroides pachygaster,* širjenje proti severu, Jadransko morje

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WESTWARD RANGE EXTENSION OF THE LESSEPSIAN MIGRANT THE SHRIMP SCAD *ALEPES DJEDABA* (FORSSKÅL, 1775) IN THE MEDITERRANEAN

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ABSTRACT

The present study reports the westward extension of the distribution range of the Lessepsian migrant fish Alepes djedaba *(Forsskål, 1775) to the island of Crete.* A. djedaba *was previously known in the Mediterranean from the eastern Levant, from Rhodes in the north to eastern Libya in the south. This record represents the 16th Lessepsian migrant for the waters surrounding Crete.*

Key words: *Alepes djedaba*, Lessepsian migration, Mediterranean, Crete, Levant

ESTENSIONE A OVEST DEL MIGRANTE LESSEPSIANO CARANGIDE *ALEPES DJEDABA* (FORSSKÅL, 1775) NEL MEDITERRANEO

SINTESI

Lo studio riporta l'estensione a ovest dell'area di distribuzione del pesce migrante lessepiano Alepes djedaba *(Forsskål, 1775) fino all'isola di Creta. La presenza di* A. djedaba *nel Mediterraneo era fino ad ora certa solo nel mare del Levante, da Rodi nella parte settentrionale fino alla Libia nella parte meridionale. Tale ritrovamento conferma la presenza del sedicesimo migrante lessepsiano nelle acque circostanti Creta.*

Parole chiave: *Alepes djedaba*, migrazione lessepsiana, Mediterraneo, Creta, Levante

INTRODUCTION

The influx of Red Sea organisms into the Mediterranean via the Suez Canal, known as Lessepsian migration, shows no sign of ceasing and encompasses almost all marine taxa. The number of Lessepsian fish species is currently close to 90, of which no less than 33 have arrived to the Mediterranean since the beginning of the 21st century.

The dynamics of population establishment and westward distribution of Lessepsian migrant fish are known and have been well documented. This record is the latest documentation of this ongoing phenomenon.

MATERIALS AND METHODS

On 9th October 2013 a ca. 180 mm specimen of *Alepes djedaba* (Forsskål, 1775) was found among the catch of trammel net fishery operating at depths of 35 m, at the port of Heraklion, Crete. The specimen was photographed but not preserved.

An additional specimen, 136 mm SL (175 mm TL) was collected on 21st October 2013 by trammel net set at 20 m at Ammoudara Beach, ca. 3 km west of Heraklion. Another specimen, 137 mm SL (176 mm TL) (Fig. 1) was collected on the following day, 22nd October 2013 using the same method at the same location. Both specimens were deposited in the Hebrew University of Jerusalem Fish Collection and received the catalogue numbers HUJ 20249 and HUJ 20250, respectively.

RESULTS AND DISCUSSION

Body ellipsoid and slightly compressed. Head 3.3-3.4 and depth 3.0-3.1 times in SL. Two dorsal fins, the first one triangular with eight spines, the first pointing forward and usually covered with skin. The second with one spine and 23 rays. Anal fin with two detached spines, one spine and 20 rays. The last dorsal and anal rays elongated. Caudal fin deeply forked. Pectoral fin falcated with 20-21 rays. Lateral line with 87-88 scutes, arched in its anterior part and becoming straighter with larger scutes under the 2nd-3rd ray of the second dorsal fin. Back and flanks grey with white belly. Conspicuous yellow dorsal fin, caudal fin and the posterior part of the lateral line scutes. A black spot on the upper edge of the operculum.

A. djedaba can be distinguished from all Mediterranean carangids by having a lateral line made of a series of thickened scutes arched in its anterior which straightens under the 1-3rd dorsal ray. *A. djedaba* also has a conspicuous yellow dorsal fin and yellow posterior part of the lateral line scutes (Smith-Vaniz, 1986).

Fig.1:** Alepes djedaba**, 137 mm SL, 22 October 2013, HUJ 20250 from Ammoudara Beach (ca. 3 km west of Heraklion), Crete, Greece.
Sl. 1:** Alepes djedaba**, 137 mm SL (standardna dolžina), 22. oktober 2013, HUJ 20250 z obale Ammoudara (pribl. 3 km zahodno od Herakliona) na Kreti, v Grčiji

In their study of Lessepsian fish migrants in the waters surrounding Crete, Peristeraki *et al.* (2006) recorded fifteen such species but *A. djedaba* was not among them. It is possible that *A. djedaba* has been in Cretan waters for some time but was overlooked.

A. djedaba was first reported from the Mediterranean as *Caranx calla* by Steinitz (1927) and subsequently under the names *Caranx djedaba, Atule djedaba* and *Alepes* (*Atule*) *djedaba* (see Golani, 2005). In subsequent years it spread westward to the eastern Aegean Sea in its south-eastern shores (Golani *et al.* 2006; Golani, 2010) and the eastern coast of Libya (Bazairi *et al.*, 2013).

A. djedaba is a schooling inshore pelagic species, feeding mainly on small fishes. Its spawning season in the Levant is during the summer. Eggs and larvae are planktonic. It is very common in Israel where it is caught in large quantities by various fishing methods.

The three reported specimens, following the observation of several other specimens in the local fishery (P. Peristeraki, unpublished data) indicate that *A. djedada* has established a vital population in the Island of Crete.

ŠIRJENJE AREALA LESEPSKE SELIVKE *ALEPES DJEDABA* (FORSSKÅL, 1775) V ZAHODNO SREDOZEMLJE

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POVZETEK

Pričujoča študija poroča o širjenju areala lesepske selivke Alepes djedaba *(Forsskål, 1775) proti zahodu na Kreto. Riba* A. djedaba *je bila prej v Sredozemlju poznana v njegovem vzhodnem delu, ki se razteza od Rodosa na severu do vzhodne Libije na jugu. Ta zapis predstavlja 16. lesepsko selivko v vodah, ki obdajajo Kreto.*

Ključne besede: *Alepes djedaba*, lesepska selitev, Sredozemlje, Kreta, Vzhodno Sredozemlje (Levant)

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FIRST RECORDS OF RANDALL'S THREADFIN BREAM *NEMIPTERUS RANDALLI* (OSTEICHTHYES: NEMIPTERIDAE) OFF THE SYRIAN COAST (EASTERN MEDITERRANEAN)

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ABSTRACT

The first records of 5 specimens of Randall's threadfin bream Nemipterus randalli *Russell, 1986 off the Syrian coast are reported in this note. These records confirm the eastern extension range of the species in the Mediterranean. The occurrence of* N. randalli *in the region and the eastern Mediterranean is commented and discussed in this report, suggesting, that a sustainable and breeding population is already established since a decade at least.*

Keywords: Nemipteridae, *Nemipterus randalli*, first records, distribution, Syrian coast, eastern Mediterranean Sea

PRIME SEGNALAZIONI DI *NEMIPTERUS RANDALLI* (OSTEICHTHYES: NEMIPTERIDAE) AL LARGO DELLA COSTA DELLA SIRIA (MEDITERRANEO ORIENTALE)

SINTESI

L'articolo riporta il ritrovamento di cinque individui di Nemipterus randalli *Russell, 1986 al largo della costa della Siria. Tali segnalazioni confermano l'estensione a est della distribuzione della specie nel Mediterraneo. La presenza di* N. randalli *nella regione e nel Mediterraneo orientale viene commentata e discussa. Gli autori ipotizzano che una popolazione sostenibile e riproduttiva si sia stabilita nell'area da almeno un decennio.*

Parole chiave: Nemipteridae, *Nemipterus randalli*, prime segnalazioni, distribuzione, costa della Siria, Mediterraneo orientale

INTRODUCTION

Randall's threadfin breams *Nemipterus randalli* Russell, 1986 is widely distributed in the western Indian Ocean, especially off India, Pakistan, Persian Gulf and in the Gulf of Aden. Additionally, the species is known off the east African coast and in waters surrounding Seychelles and Madagascar (Russell, 1990). *N. randalli* is reported in the Red Sea including the Gulf of Aqaba (Baranes & Golani, 1993; Golani & Bogorodsky, 2010). The first Mediterranean record of *N. randalli* was reported in the eastern Levantine Basin by Golani & Sonin (2006), but wrongly identified as *Nemipterus japonicus* (Bloch, 1791). At present, the species appears to be up to date successfully established in some areas of the eastern Mediterranean such as the Turkish marine waters (Erguden *et al*., 2010) and the close coast of Lebanon (Lelli *et al*., 2008).

Surveys conducted off the Syrian coast since 2000 allowed to collect specimens of *N. randalli* which are presented and described in this short report, concomitantly the distribution of the species in the region and the eastern Mediterranean is commented and discussed.

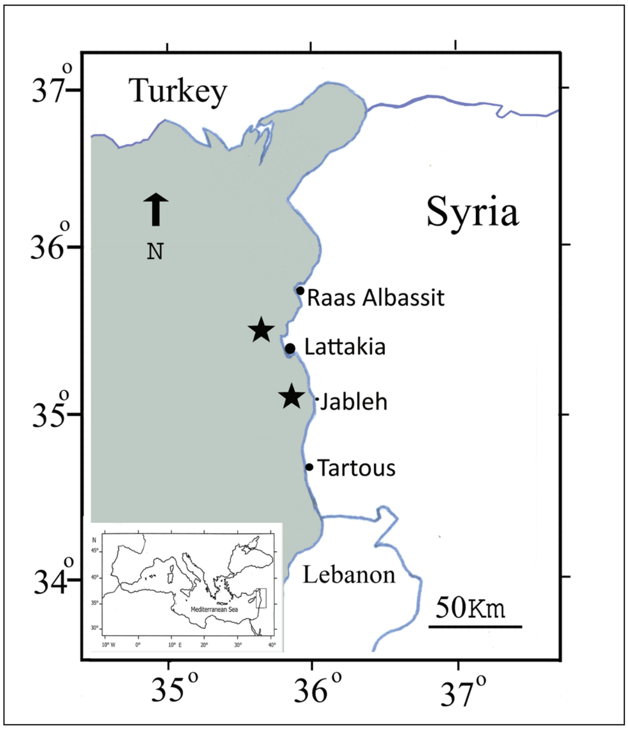

Fig. 1: *Map of the Mediterranean showing Syria and map of the coast of Syria pointing out the capture sites of Randall's threadfin breams* Nemipterus randalli *(black stars).*
Sl. 1: *Zemljevid Sredozemlja, ki prikazuje Sirijo, ter zemljevid obrežnih voda Sirije, na katerem so označena mesta zajetja vrste* Nemipterus randalli *(črne zvezdice)*

MATERIAL AND METHODS

Two specimens of *N. randalli* were caught on 21 September 2013, using a bottom handlining of nylon rope n 80°, at a depth of approximately 25 m, on sandy-rocky bottom. The capture site was located 2 km off Rass Eben Hanni harbour (35° 36′ N, 35° 40′ E), 5 km north of Lattakia (Fig. 1). Additionally, three specimens were caught on 6 November 2013, using a bottom handlining of nylon rope n 70°, at a depth of approximately 20 m, on sandy-rocky bottom. The capture site was located 4 km off Jablah City (35° 21′ N, 35° 48′ E). The five specimens were measured to the nearest millimetre and weighed to the nearest gram. Morphometric measurements with percents of standard length (SL) and counts followed Russell (1990), Golani & Sonin (2006) and Lelli *et al.* (2008) and were included in Table 1. All specimens were preserved in 10% buffered formalin and deposited in the Ichthyological Collection of the Marine Sciences Laboratory, Agriculture Faculty at Tishreen University, Syria under the catalogue numbers: 255 M.S.L., 256 M.S.L. (Fig. 2), 257 M.S.L., 258 M.S.L. and 259 M.S.L. respectively.

RESULTS AND DISCUSSION

The Syrian specimens were identified following Russell (1990), with main characteristic features as snout length about equal to eye diameter, interobital width 1.4 to 2.0 in eye, pectoral and pelvic fins very long, reaching to or just beyond level of origin of anal fin, caudal fin forked, upper rays produced into a long trailing filament; body compressed silvery-pink with 3-4 yellow stripes on sides below lateral line, eye salmon pink, dorsal fin pale bluish, caudal fin pink, caudal filament reddish, pelvic fins whitish, pectoral fins transparent. Additionally, morphometric measurements (including percent of standard length - SL) and counts are in total

Fig. 2: *Nemipterus randalli* **captured off the Syrian coast: specimen referenced 256 M.S.L, scale bar = 50 mm.**
Sl. 2: *Vrsta* *Nemipterus randalli****, zajeta ob sirski obali: primerek, zabeležen kot 256 M.S.L, tračno merilo = 50 mm***

Tab. 1: *Morphometric measurements in mm and as a percentage of standard length (%SL), a weight in gram recorded in the 5 specimens of* Nemipterus randalli *caught off the Syrian coast.*
Tab. 1: *Morfometrične mere v milimetrih in v odstotkih standardne dolžine (% SL) ter teža v gramih, zabeleženi pri petih primerkih vrste* Nemipterus randalli*, zajetih ob obali Sirije*

Reference of specimens	**255 M.S.L**		**256 M.S.L**		**257 M.S.L**		**258 M.S.L.**		**259 M.S.L**	
Morphometric measurements	**mm**	**%SL**	**mm**	**%SL**	**mm**	**%SL**	**mm**	**%SL**	**mm**	**%SL**
Standard length	128	100.0	121	100.0	173	100.0	186	100.0	151	100.0
Total length	176	137.5	165	136.4	269	155.5	247	131.1	198	132.8
Total length without filament	161	125.8	151	124.8	233	134.7	-	-	-	-
Filament length	17	13.3	16	13.2	34	19.7	-	-	-	-
Forked length	144	112.5	137	113.2	216	124.9	214	112.6	170	115.1
Head length	42	32.8	40	33.1	58	33.5	58	33.8	51	31.2
Interorbital space	9	7.0	8	6.6	12	6.9	14	6.0	9	7.5
Eye horizontal diameter	12	9.4	12	9.9	15	8.7	16	9.9	15	8.6
Eye vertical diameter	12	9.4	12	9.9	13	7.5	15	9.3	14	8.1
Iris horizontal diameter	6	4.7	5	4.1	7	4.0	7	3.3	5	3.8
Iris vertical diameter	5	3.9	5	4.1	5	2.9	6	4.0	6	3.2
Snout length	13	10.2	12	9.9	11	6.4	13	7.3	11	7.0
Upper jaw length	14	10.9	13	10.7	18	10.4	18	9.3	14	9.7
Lower jaw length	15	11.7	14	11.6	19	11.0	18	9.3	14	9.7
Pectoral fin length	44	34.4	40	33.1	56	32.4	64	30.5	46	34.4
Pectoral fin base	9	7.0	8	6.6	10	5.8	7	6.0	9	3.8
Dorsal fin length	84	65.6	74	61.2	121	69.9	123	66.9	101	66.1
Dorsal fin base	66	51.6	60	49.6	95	54.9	97	51.7	78	52.2
Dorsal fin height	13	10.2	12	9.9	14	8.1	19	10.6	16	10.2
Pelvic fin length	38	29.7	33	27.3	58	33.5	56	31.8	48	30.1
Pelvic fin base	7	5.5	7	5.8	7	4.0	8	4.0	6	4.3
Pelvic axillary scale process length	8	6.3	7	5.8	11	6.4	11	6.0	9	5.9
Anal fin length	38	29.7	36	29.8	57	32.9	61	30.5	46	32.8
Anal fin base	25	19.5	22	18.2	35	20.2	37	19.2	29	19.9
Anal fin height	12	9.4	11	9.1	15	8.7	16	9.3	14	8.6
Body depth	39	30.5	37	30.6	56	32.4	58	28.5	43	31.2
Pre-pectoral length	45	35.2	40	33.1	59	34.1	63	33.8	51	33.9
Pre-dorsal length	43	33.6	41	33.9	54	31.2	61	35.1	53	32.8
Pre-anal length	84	65.6	78	64.5	112	64.7	122	64.2	97	65.6
Pre-pelvic length	44	34.4	38	31.4	64	37.0	68	36.4	55	36.6
Caudal peduncle length	18	14.1	17	14.0	26	15.0	26	13.2	20	14.0
Suborbital depth	5	3.9	4	3.3	9	5.2	9	4.6	7	4.8
First dorsal spine length	9	7.0	9	7.4	11	6.4	8	5.3	8	4.3
Longest spine length of dorsal fin	16	12.5	13	10.7	17	9.8	21	11.9	18	11.3
Counts	**255 M.S.L**		**256 M.S.L**		**257 M.S.L**		**258 M.S.L.**		**259 M.S.L**	
Pelvic fin spinous rays	1+ axillary scale		1+ axillary scale		1+ axillary scale		1+ axillary scale		1+ axillary scale	
Pelvic fin soft rays	5		5		5		5		5	
Anal fine spinous rays	3		3		3		3		3	
Anal fin soft rays	7		7		7		7		7	
Pectoral fin spinous rays	-		-		-		-		-	
Pectoral fin soft rays	16		16		16		16		16	
Caudal fin soft rays	20		20		20		18		18	
Lateral line scales	49		48		48		45		48	
Total weight (g)	144		82		148		182		93	

agreement with Russell (1990), Golani & Sonin (2006) and Lelli *et al.* (2008). So, these findings constitute the first records of *N. randalli* off the Syrian coast, and the species could be included in the local ichthyofauna (see Saad, 2005). Consequently, the occurrence of *N. randalli* in the Mediterranean Levant Basin is confirmed, suggesting that a sustainable population is established in the region.

The definitive intrusion and expansion of an alien species such as *N. randalli* in the eastern Mediterranean could constitute a new case of a probable competition pressure with indigenous species. For instance, the drastic decline of captures of Salema *Sarpa salpa* (Linnaeus, 1758) in the area is probably due to a competition pressure for food with a Lessepsian migrant marbled spinefoot *Siganus rivulatus* (Forsskål 1775), both species being herbivorous (Bariche *et al.*, 2004). Niche displacements were also reported between indigenous and invasive species (Golani & Galil, 1991; Lelli *et al.*, 2008). Bluespotted cornetfish, *Fistularia commersonii* Rüppell, 1838 described as a 'Lessepsian sprinter' by Karachle *et al*. (2004) rapidly expanded in the eastern Mediterranean Sea (Golani *et al.*, 2002). *F. commersonii* is at present abundantly collected throughout the Tunisian coast (Rafrafi-Nouira *et al*., 2012) where it constitutes an ecological danger for sparid species, such as gilt-head sea bream *Sparus aurata* Linnaeus, 1758, having locally a high economical interest.

In total agreement with Lelli *et al.* (2008), the successful establishment of a breeding population of *N. randalli* off the coasts of Syria and Lebanon deserves a thorough study in order to show its role in the local ecosystem and its impact on indigenous species, mainly on the related species belonging to the family of Sparidae, greatly appreciated for local consumption and exported outside their areas of capture.

PRVI PODATKI O VRSTI *NEMIPTERUS RANDALLI* (OSTEICHTHYES: NEMIPTERIDAE) OB SIRSKI OBALI (VZHODNO SREDOZEMLJE)

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POVZETEK

Članek navaja prve podatke o petih primerkih vrste Nemipterus randalli *(Russell, 1986), zajetih ob sirski obali, ki potrjujejo, da je omenjena vrsta razširjena tudi v vzhodni predel Sredozemlja. Avtor obravnava pojavljanje vrste* N. randalli *na tem področju in v vzhodnem Sredozemlju in sklepa, da je trajna in razmnožujoča se populacija tu ustaljena že vsaj desetletje.*

Ključne besede: Nemipteridae, *Nemipterus randalli*, prvi podatki, razširjenost, sirska obala, vzhodno Sredozemsko morje

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SREDOZEMSKI MORSKI PSI

SQUALI DEL MEDITERRANEO

MEDITERRANEAN SHARKS

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RARE BUT PRESENT: STATUS OF BASKING SHARK, *CETORHINUS MAXIMUS* (GUNNERUS, 1765) IN EASTERN MEDITERRANEAN

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ABSTRACT

Extremely low number of records off Turkish coast from 1950's to date confirmed the rarity of Cetorhinus maximus *in Turkish waters. A specific scientific monitoring program accompanied by zooplankton surveys should be implemented as soon as possible to figure out the seasonal movements of* C. maximus *in the mentioned region to answer the question whether the occurrence of basking sharks in Turkish waters exhibits a seasonality and site fidelity or not?*

Key words: basking shark, *Cetorhinus maximus*, Turkey, eastern Mediterranean, coastal netting, site fidelity

RARO MA PRESENTE: LO STATO DELLO SQUALO ELEFANTE, *CETORHINUS MAXIMUS* (GUNNERUS, 1765), NEL MEDITERRANEO ORIENTALE

SINTESI

Un numero estremamente basso di segnalazioni al largo della costa turca dal 1950 fino ad oggi ha confermato la rarità di Cetorhinus maximus *nelle acque della Turchia. Gli autori auspicano che un programma specifico di monitoraggio scientifico, accompagnato da indagini del zooplancton, venga attuato al più presto al fine di capire i movimenti stagionali di* C. maximus *nella regione studiata. Con tali dati si potrebbe verificare se le segnalazioni di squali elefante nelle acque turche presentano o non presentano una stagionalità e una fedeltà al sito.*

Parole chiave: squalo elefante, *Cetorhinus maximus*, Turchia, Mediterraneo orientale, reticolato costiero, fedeltà al sito

INTRODUCTION

The presence of basking shark, *Cetorhinus maximus* (Gunnerus, 1765), in the Mediterranean basin has been recorded since 1795 (Mancusi *et al*., 2005). In a recent survey on the presence of *C. maximus* in the Mediterranean Sea, Mancusi *et al*. (2005) collected 535 records of basking shark, from 1795 to 2002, mostly in the western and central regions of the Mediterranean area. Mancusi *et al*. (2005) and Serena (2005) also emphasized the scarcity of basking shark presence in the eastern Mediterranean. The occurrence of *C. maximus* in the Levantine basin has also been noted by Golani *et al*. (2006).

Although the first documented record of *C. maximus* off Turkish coast has been reported by Kıdeyş (1997), based on incidental captures of two individuals in May 1995, a recent survey revealed that historical occurrence of this species in the mentioned region dates back to 1950's (Kabasakal, 2004). Recent catches and sightings of basking sharks along Aegean and Mediterranean coasts of Turkey allow the author to suggest that *C. maximus* is rare in the study area, as it has been previously supposed (Kabasakal, 2002, 2004, 2009; Kabasakal & Kabasakal, 2004).

Since current knowledge on the occurrence of basking shark in eastern Mediterranean has remarkable gaps, every individual record from the area is valuable to complete the big picture. In the present article, a brief discussion on the occurrence of *C. maximus* in Levantine basin is provided in the light of available data.

MATERIAL AND METHODS

Data on basking sharks have been collected from the following sources: (a) scientific literature; (b) daily newspapers and internet sources, as far as such popular sources are concerned, the validity of the recordings has been confirmed by means of direct contact with the fishermen reported in the source; and (c) visiting the fishing ports. For each examined basking shark, the following data were recorded: total length (TL), weight (W), sex, date and locality, fishing gear and depth. Photographs of the examined basking sharks, of which the details are given below, are kept in the archives of Ichthyological Research Society (IRS). Pdf copies of internet sources are available on request for inspection.

RESULTS AND DISCUSSION

Basking shark is one of the well-documented lamniform sharks in the Mediterranean Sea, of which the majority of records have been reported from western and central regions of the entire basin since late 18th century (Mancusi *et al*., 2005). Being the second largest fish occurring in the oceans, this charismatic gentle giant has always been a subject of research, as well as an unfortunate target of fishery (Compagno, 1984). Despite

Fig. 1: Basking shark, ca. 1000 cm TL (sp no. 11 in Table 1), caught off Küçükkuyu coast in Edremit Bay, northeastern Aegean Sea. Details of this specimen are given in Kabasakal (2009).
Sl. 1: Morski pes orjak, dolžine pribl. 1000 cm (primerek št. 11 iz tabele 1), ulovljen blizu Küçükkuyujske obale v Edremitskem zalivu v severovzhodnem delu Egejskega morja. Podrobnosti o tem primerku so navedene v publikaciji Kabasakal (2009).

its well-documented western and central Mediterranean records (Soldo & Jardas, 2002; Capapé *et al.*, 2003; Mancusi *et al.*, 2005), the scarcity of *C. maximus* records from Levantine basin creates a hole of uncertainties in the distributional map of this species in the entire Mediterranean region.

Historically, basking shark occurrence in the Aegean Sea has been documented since late 1940s, based on specimens caught off Cyclades, Chios, Lesvos and Dodecanese islands (Belloc, 1948, in Papakonstantinou, 1988). Following this pioneering record, on 16 May 1997, a large individual of *C. maximus* (TL ca. 800 cm) has been sighted by a swordfish harpooner off southern coast off Gökçeada Island in northeastern Aegean Sea (Kabasakal & Kabasakal, 2004). Recently, a large basking shark of ca. 1000 cm TL, was entangled in stationery nets set only 2 miles off Küçükkuyu coast in Edremit Bay, northeastern Aegean Sea (Fig. 1; Kabasakal, 2009). This basking shark, caught on 2 January 2009, was considered as the largest well-documented *C. maximus* individual recorded in the Mediterranean to date. Finally, two basking sharks, both over 700 cm and weighing roughly 2000 kg, have been incidentally captured by net fishermen off the coast south of Athens, Greece (Shark Alliance, 2009). One of the two basking sharks has been caught on 9 March 2009 and the other one just five days later, according to press release by Shark Alliance given on 19 March 2009. These two basking sharks incidentally captured in waters off Athens coast are probably the most recent records of *C. maximus* from Aegean Sea to date.

Historical records of basking sharks from the Bay of İskenderun date back to 1950s (Kabasakal, 2004). Ben-Tuvia (1971) reported on two young basking sharks accidentally caught off Akko coast, (Israel), one of them was entangled in a gill-net set at a depth of 3 m. Following Ben-Tuvia's (1971) report, another basking shark was accidentally captured in the Bay of Antalya in 1987 by stationary nets set very close to the shore (Kabasakal, 2004). Subsequent to 1987 record of basking shark in Bay of Antalya, further records of *C. maximus* have been reported along Turkish Mediterranean coast (Kıdeyş, 1997; Kabasakal, 2002, 2013). Recently, Ali *et al.* (2012) reported on the capture of a basking shark off the Syrian coast. It was entangled in a gill-net, spread from the beach to 150 m in the sea, at a depth of approximately 10 m, off Raas Albassit, on 20-21 April 2012 (Ali *et al.*, 2012). Finally, on 12 May 2013, a 400 cm long basking shark was caught off Famagusta harbour (Cyprus, eastern Mediterranean Sea), according to report published on LGC News website, dated 13 May 2013 (LGC News, 2013). Famagusta incidence is probably the most recent eastern Mediterranean record of *C. maximus* to date. Available historical and contemporary records of *C. maximus* from Aegean Sea and eastern Mediterranean are summarised in Table 1 and plotted on the map in Figure 2.

All of basking sharks recorded off Turkish coast, as well as some individuals recorded off Syrian and Israeli coasts, have been caught in shallow coastal waters by stationary- or gill-netters. According to Mancusi *et al.* (2005), most of the occurrences of *C. maximus* in Mediterranean are reported off the coastal areas of the western and central sectors of the entire basin, where this species is often caught incidentally by trammel nets. Since the basking sharks are seem to be philopatric and may show the tendency to return seasonally to the same coastal feeding locations (Mancusi *et al.*, 2005), coastal netting is a serious threat endangering the survival of *C. maximus* throughout its Mediterranean distribution. Capapé *et al.* (2003) noted that specimens of basking sharks from the Maghrebin coastal waters were caught at depths of max. 30 m. Incidental capture of young basking sharks by coastal netters off Piran (Gulf of Trieste, northern Adriatic) were recorded by Lipej *et al.* (2000). Fifteen percent of the total 323 incidental catches of *C. maximus* came from trammel nets, a kind of stationary net (Mancusi *et al.*, 2005).

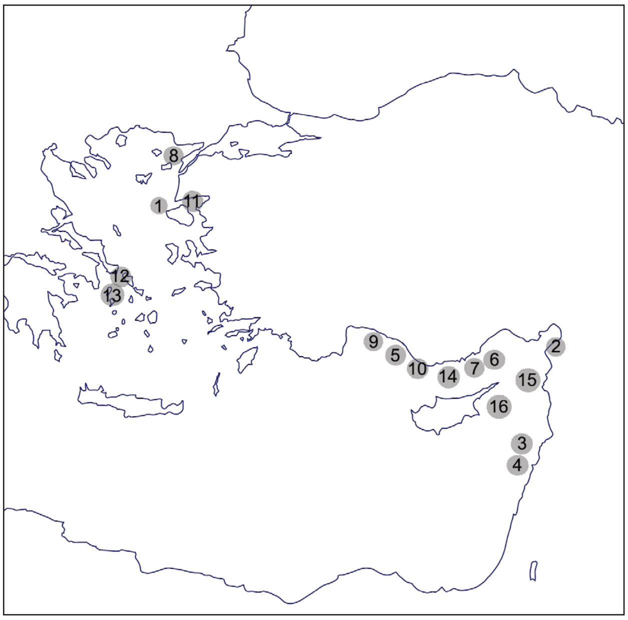

Fig. 2: Approximate localities of historical and contemporary records of *C. maximus* ***from Aegean Sea and eastern Mediterranean; circled numbers are same as the numbers seen in the No column of Table 1.***
Sl. 2: Približne lokacije zgodovinskih in sodobnih zapisov o vrsti *C. maximus* ***v Egejskem morju in vzhodnem Sredozemlju; obkrožene številke ustrezajo številkam v prvem stolpcu Tabele 1***

The relation between the occurrence of basking sharks and zooplankton abundance has been suggested previously by Sims & Merrett (1997). According to them, basking sharks can forage actively to locate more productive zooplankton patches. Since few records of *C. maximus* in the eastern Mediterranean area correspond to small coastal zones, where the chlorophyll concentration is a little bit higher (*e.g.* coast of Turkey), assu-

med relation between the basking shark presence and zooplankton abundance (Sims & Merrett, 1997) can provide an explanation on the occurrence of *C. maximus* off Turkish coast. Recent surveys showed that abundance of larger copepods, one of the main prey group in the diet of basking sharks (Sims & Merrett, 1997), increased remarkably in winter and spring months around Gökçeada and Bozcaada islands, as well as in the Bay of Edremit (Tarkan, 2000), where Aegean records of *C. maximus* have been recorded during the same period of year (Table 1). In Bay of Mersin, where some of the Mediterranean records of *C. maximus* off Turkish coast were reported, annual average zooplankton biomass in coastal waters was about nine times higher than in open waters (Zenginer & Beşiktepe, 2007).

In Turkish waters, basking shark is considered to be a rare and occasional species (Akşıray, 1987). Extremly low number of records off Turkish coast from 1950's to date (9 specimens; table 1) supposed to confirm the rarity of *C. maximus* in Turkish waters; however, the scarcity of information on incidental captures and sightings of basking sharks in the seas of Turkey can be explained by the lack of a dedicated specific scientific monitoring in this area, which was also suggested to explain the probable reason of poor information on *C. maximus* records from eastern Mediterranean by Mancusi *et al*. (2005). Since the records of basking sharks in Turkish waters concentrate in certain areas (Bay of Edremit and periphery, northeastern Aegean Sea; bays of Antalya, Mersin and İskenderun, eastern Mediterranean Sea), a specific scientific monitoring program accompanied by zooplankton surveys should be implemented as soon as possible to figure out the seasonal movements of *C. maximus* off Turkish coast to answer the question whether the occurrence of basking sharks in the mentioned region exhibits a seasonality and site fidelity or not? Such a survey is necessary before implementing precautions against coastal netting in certain marine areas to prevent the basking shark mortality in Turkish waters.

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I am indebted to fishermen from Küçükkuyu, Antalya, Mersin and İskenderun fishingports for their help during field surveys. A special thank goes to author's wife (Özgür) and son (Derin) for their endless love and support.

Tab. 1: Historical and contemporary records of* C. maximus *from Aegean Sea and eastern Mediterranean. AE: Aegean Sea; EM: Eastern Mediterranean; TR: Turkey; GR: Greece; SR: Syria; IL: Israel; CY: Cyprus.
Tab. 1: Zgodovinski in sodobni zapisi o vrsti* C. maximus *v Egejskem morju in vzhodnem Sredozemlju. EM: Egejsko morje; VS: vzhodno Sredozemlje; TR: Turčija; GR: Grčija; SR: Sirija; IL: Izrael; CY: Ciper

No	Date	Region	TL (cm)	W (kg)	Depth (m)	Fishing gear	Reference
1	1940's	AE-GR	-	-	-	-	Belloc (1948, in Papakonstantinou, 1988)
2	1950's	EM-TR	-	-	-	-	Kabasakal (2004)
3	11 Jan 1965	EM-IL	267	-	3	Gill-net	Ben-Tuvia (1971)
4	7 Mar 1965	EM-IL	259	-	-	-	Ben-Tuvia (1971)
5	1987	EM-TR	400	800	-	Stationary net	Kabasakal (2004)
6	May 1995	EM-TR	470	-	-	Stationary net	Kıdeyş (1997)
7	May 1995	EM-TR	-	-	-	Stationary net	Kıdeyş (1997)
8	16 May 1997	AE-TR	ca. 800	-	-	Sighting	Kabasakal & Kabasakal (2004)
9	Dec 2001	EM-TR	600	-	-	Gill-net	Kabasakal (2002)
10	30 Dec 2006	EM-TR	300	-	-	Stationary net	Kabasakal (2013)
11	2 Jan 2009	AE-TR	ca. 1000	ca. 2000	-	Stationary net	Kabasakal (2009)
12	9 Mar 2009	AE-GR	>700	ca. 2000	-	Net, type unknown	Shark Alliance (2009)
13	14 Mar 2009	AE-GR	>700	ca. 2000	-	Net, type unknown	Shark Alliance (2009)
14	7 Apr 2012	EM-TR	236	70	1.5	Gill-net	Kabasakal (2013)
15	20-21 Apr 2012	EM-SR	690	ca. 2500	10	Gill-net	Ali *et al*. (2012)
16	12 May 2013	EM-CY	400	-	-	Net, type unknown	LGC News (2013)

REDEK, TODA PRISOTEN: STATUS MORSKEGA PSA ORJAKA *CETORHINUS MAXIMUS* (GÜNNERUS, 1765) V VZHODNEM SREDOZEMLJU

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POVZETEK

*Izjemno majhno število zapisov o pojavljanju morskega psa orjaka (*Cetorhinus maximus*) ob turški obali od 50. let prejšnjega stoletja do danes potrjuje njegovo redkost v turških vodah. Čim prej bi bilo treba izvesti poseben program znanstvenega monitoringa s spremljajočimi raziskavami o zooplanktonu, da bi ugotovili sezonsko gibanje te vrste morskega psa na omenjenem območju in odgovorili na vprašanje, ali pojavljanje vrste* C. maximus *v turških vodah izkazuje sezonskost in filopatrijo ali ne.*

Ključne besede: morski pes orjak, *Cetorhinus maximus*, Turčija, vzhodno Sredozemlje, nameščanje priobalnih mrež, filopatrija

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THE MARANO AND GRADO LAGOON: A BRIEF SYNOPSIS ON THE AQUATIC FAUNA AND FISHERIES RESOURCES

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ABSTRACT

*The Marano and Grado Lagoon is one of the best preserved wetlands in the whole Mediterranean area. In spite of the presence of chemical pollutants, especially mercury, no clear criticism of the ecological status for macrozoobenthos and fish fauna was found. The distribution of macrozoobenthos species shows a clear relationship with the salinity gradient, due to both the renewal time of seawater and the freshwater inputs from the inland. The Lagoon constitutes an important habitat for fish fauna, particularly for the sensitive species, and a nursery ground for juveniles of marine migrants especially in the inner area of Marano basin. After 25 years from the introduction of Manila clam (*Venerupis philippinarum*), the pathway toward its sustainable aquaculture seems now possible.*

Key words: Marano and Grado Lagoon, northern Adriatic Sea, fish fauna, macrozoobenthos, fisheries resources

LAGUNA DI MARANO E GRADO: BREVE SINOSSI SULLA FAUNA ACQUATICA E LE RISORSE ITTICHE

SINTESI

*La Laguna di Marano e Grado è una delle zone umide meglio conservate di tutto il Mediterraneo. Nonostante la presenza di sostanze chimiche inquinanti, in particolare di mercurio, non sono state rilevate criticità evidenti in merito allo stato ecologico del macrozoobenthos e della fauna ittica. La distribuzione dei popolamenti macrozoobentonici dimostra una chiara relazione con il gradiente di salinità, dovuto ai tempi di ricambio con le acque marine e agli apporti di acque dolci di origine continentale. La laguna costituisce un importante habitat per la fauna ittica, in particolare per le specie considerate sensibili, nonché rappresenta un'area di nursery per il novellame delle specie marino migratorie, specialmente nella zona più interna del bacino di Marano. Dopo 25 anni dall'introduzione della vongola filippina (*Venerupis philippinarum*), il percorso verso la sua acquacoltura sostenibile sembra finalmente possibile.*

Parole chiave: Laguna di Marano e Grado, Alto Adriatico, fauna ittica, macrozoobenthos, risorse ittiche.

INTRODUCTION

The Marano and Grado Lagoon (hereafter referred as Lagoon) is one of the best preserved wetlands in the whole Mediterranean area. It is a shallow system, extending for approximately 32 km reaching up to 5 km of width for a total area of 160 km^2, located between the Tagliamento and Isonzo River deltas. The Lagoon is separated from the Adriatic Sea by six barrier islands (1.6 to 6 km long, for a total length of 20 km; 12 km wide) (Fontolan *et al.,* 2012). A central 8 m deep canal (Porto Buso), employed for navigation and commercial shipping separates the Marano basin (western part) from the Grado basin (eastern part). The whole basin is affected by semi-diurnal tidal fluxes (65 cm and 105 cm mean and spring tidal range, respectively) (Covelli *et al.,* 2008) and, on the basis of its salinity, by applying the Water Framework Directive (Directive 2000/60/EC), three main water types were identified (Fig. 1): mesohaline TME (salinity 5–20), polyhaline TPO (salinity 20–30) and euhaline TEU (salinity 30–40) (Bettoso *et al*., 2010).

The drainage basin of the Lagoon covers an area of about 1,880 km^2 and delivers important loads of both nutrients and pollutants. The main freshwater inputs are: the spring rivers (Stella, Turgnano, Zellina, Ausa-Corno, Natissa and Tiel) and the River Cormor, featuring a mountain watershed and the 30 drainage pumps of the low Friulian plain. In 2009 the Autorità di Bacino Regionale (ABR-FVG) calculated the mean discharge of the rivers alone as 81.5 m^3 s^{-1}, of which the main contributors are the Stella River (36.1 m^3 s^{-1}) and the Cormor River (10.7 m^3 s^{-1}). There are no data available regarding sediment load (Fontolan *et al.,* 2012). The Stella River is particularly important for its estuarine habitats. The main source of particulate matter comes from the sea, through the Tagliamento and Isonzo River deltas, and from the erosion of the barrier islands. The dispersion of sediments into the lagoon is mainly controlled by tidal fluxes through tidal inlets (Fontolan *et al.,* 2012).

The Lagoon is protected by the Ramsar Convention since 1971 (Convention on Wetlands of International Importance especially as Waterfowl Habitat, 1971). Following the implementation of the Habitats Directive (Council Directive 92/43/EEC), which concerns the protection of biodiversity, the Lagoon was included in the “Natura 2000” ecological network of protected are-

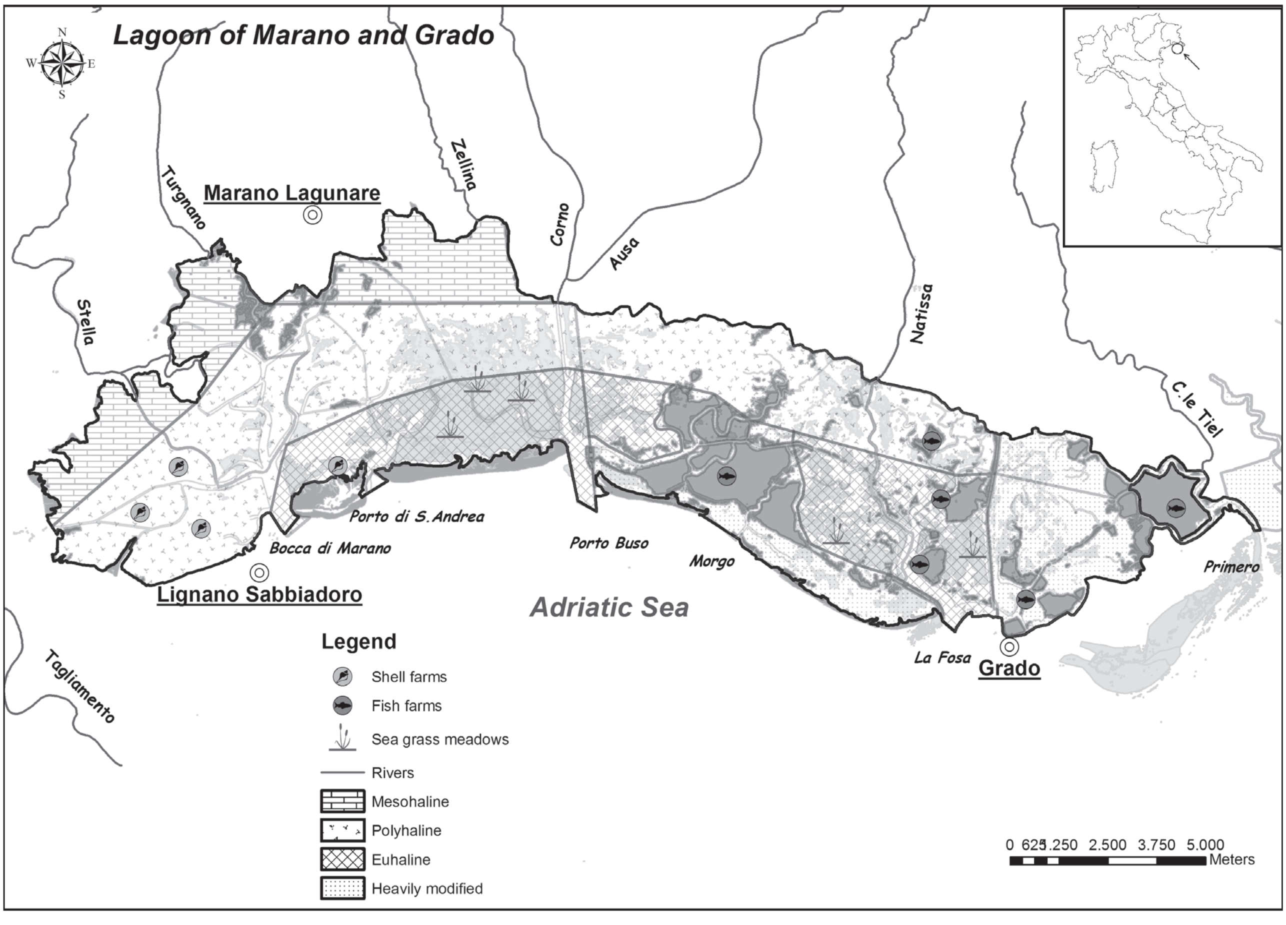

Fig. 1: The Marano and Grado Lagoon and water types according to the Directive 2000/60/EC.
Sl. 1: Maranska in Gradeška laguna in vodne tipologije v skladu z Direktivo 2000/60/ES

as (SCIs – IT3320037). The whole area hosts economic, tourism and industrial services, with fishing, clam harvesting (mainly *Venerupis philippinarum*) and fish-farming comprising the most important resources for today's local inhabitants (Fig. 1).

On the other hand, this system has a high degree of vulnerability due to the surrounding level of urbanisation and industry. In detail, the Lagoon experienced some remarkable environmental impacts which have affected the high natural value of the ecosystem and consequently influenced relevant socio-economic aspects (Covelli, 2012). At Porto Nogaro, located about 1 km north of the Ausa-Corno River mouth, several productive settlements are still present (*i.e.*, beer production, wood and plastics processing, magnesium, iron and steel production and wreckage). In addition, one of the main concern is related to the Torviscosa industrial site where processing of several chemical compounds, such as cellulose, chlor--alkali and textile artificial fibres were active since the 40-50's and are still in production (RAFVG, 1991; Caffaroindustrie, 2013). These factories, which are located inland, are responsible for contamination of soils and groundwaters especially with mercury (Hg), whereas the occurrence of other contaminants such as heavy metals (cadmium, zinc, arsenic, lead and copper), polychlorinated dibenzodioxins (PCDDs), furans (PCDFs) and polycyclic aromatic hydrocarbons (PAHs), is closely related to the location of the different chemical productions that took place in the industrial site (Menchini *et al*., 2009). Moreover, about 220,000 m^3 of wastes (fly ashes, pyrite ashes, toluene and benzoic pitch, barks, etc.) are located in the nearby areas. Due to this, in order to protect and manage, the Lagoon has been declared a "polluted site of national interest" because of its high level of sanitary and environmental risk (Ramieri *et al*., 2011).

Due to the presence of these chemical pollutants the aim of this paper is to show the main features of macrozoobenthos, fish fauna and fisheries resources in the Lagoon of Marano and Grado on the basis of basic literature and current monitoring programmes within the WFD 2000/60/CE application.

MATERIAL AND METHODS

The ecological status of the macrozoobenthic communities was assessed by Bettoso *et al.* (2010) according with the application of the Water Framework Directive (WFD 2000/60/CE). Benthic samples were collected by a 0.047 m^2 van Veen grab in May 2008 and the main features of the macrozoobenthos outlined by Bettoso *et al.* (2010) are reported.

A three years monitoring program (2010-2012) of fish fauna was carried out on 33 sampling stations with the aid of local fishermen by means of fyke nets. This represents a traditional and ancient fisheries method which is spread along the northern Adriatic lagoons. The fyke net consists of a barrier (about 60 m in length and 1.3 m in height) with a 0.7 cm mesh size, which leads the fish and the shrimps towards four cone shaped, unbaited traps, of the same mesh size. This kind of fishing gear takes advantage from the tidal dynamics in order to catch fish and shrimps, and the barriers are set sideways on the tide currents (Malavasi *et al*., 2004). All samples were collected after 24 hours from the setting of the fyke nets. The fish taxa were classified at a species level and the abundance was measured by counting the individuals caught in the trap end.

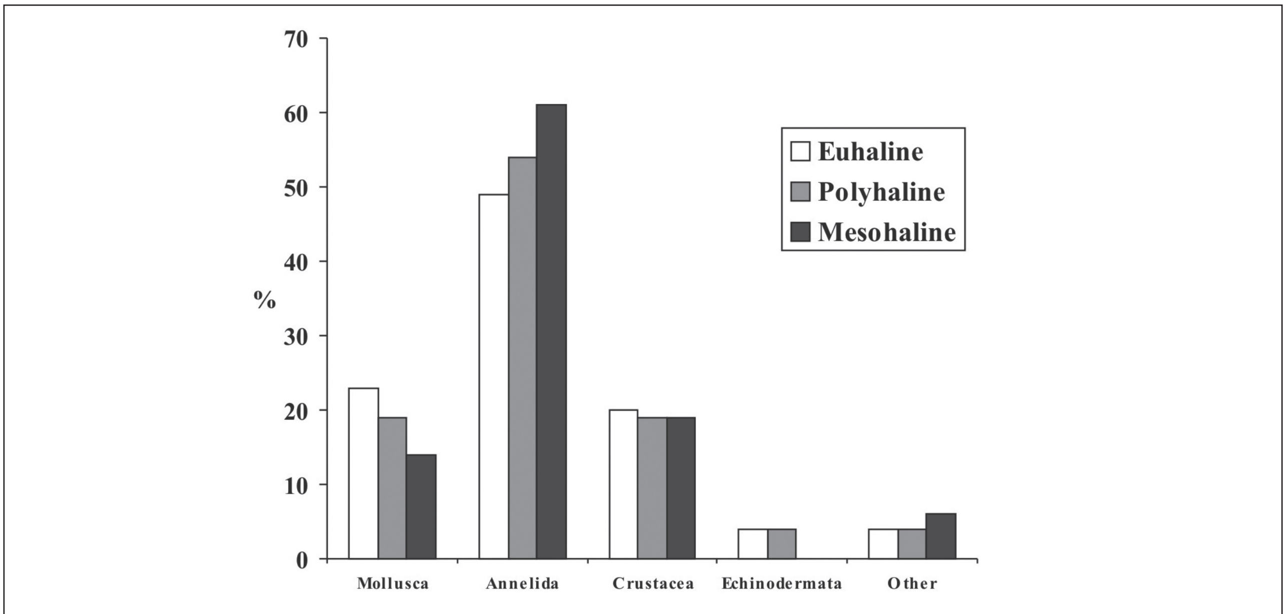

Fig. 2: Percentage subdivision of main taxa for euhaline, polyhaline and mesohaline water types.
Sl. 2: Porazdelitev glavnih taksonov (v odstotkih) za vodne tipologije: evhalina, polihalina in mezohalina

Tab. 1: Fish species recorded during the three years monitoring and related Estuarine Use Functional Group (EUFG) according to Franco** et al.* ***(2008): (ES) estuarine species, (MM) marine migrants, (MS) marine stragglers, (F) freshwater species, (A) anadromous species, (C) catadromous species. (*) indicates juvenile specimens

Tab. 1: Ribje vrste, zabeležene v treh letih programa spremljanja stanja, in z njimi povezane ekološke funkcionalne estuarijske skupine (EUFG) v skladu s Franco** et al.* ***(2008): (ES) stalne estuarijske vrste, (MM) morske selivke, (MS) občasne morske selivke, (F) sladkovodne vrste, (A) anadromne vrste, (C) katadromne vrste. (*) označuje juvenilne osebke

EUFG	Species
A	*Alosa fallax**
C	*Anguilla anguilla*
ES	*Aphanius fasciatus*
ES	*Atherina boyeri*
MM	*Belone belone*
MS	*Boops boops**
MS	*Conger conger**
F	*Cyprinus carpio**
ES	*Diplecogaster bimaculatus*
MM	*Diplodus annularis**
MM	*Engraulis encrasicholus**
ES	*Gambusia affinis*
F	*Gasterosteus aculeatus*
ES	*Gobius niger*
ES	*Gobius paganellus*
ES	*Hippocampus guttulatus*
ES	*Hippocampus hippocampus*
ES	*Knipowitschia panizzae*
MM	*Liza aurata**
C	*Liza ramada**
C, ES, MM	*Mugil cephalus**
MM, MS	*Mullus surmuletus**
MS	*Pagellus acarne**
MS	*Parablennius sanguinolentus*
MM	*Platichthys flesus**
MS	*Pomatomus saltatrix**
ES	*Pomatoschistus canestrinii*
ES	*Pomatoschistus marmoratus*
MM	*Pomatoschistus minutus*
F	*Pseudorasbora parva*
F	*Rutilus aula*
ES	*Salaria pavo*
MM	*Sardina pilchardus**
MM	*Solea solea**
MM	*Sparus aurata**
MS	*Sphyraena sphyraena**
MS	*Symphodus cinereus*
MM	*Syngnathus acus*
ES	*Syngnathus typhle*
MS	*Trachurus mediterraneus**
ES	*Zosterisessor ophiocephalus*

On regard of the fisheries resources in the Lagoon, a 10 years dataset of total catches (2000-2010) collected by fish market of Marano Lagunare and Grado cities was considered. Percentage abundance of the main resources were considered for each fisheries port, whereas in order to describe the aquaculture Lagoon status the basic literature from Sladonja *et al*. (2011) and Zentilin (2008) were considered.

RESULTS AND DISCUSSION

Macrozoobenthos

During 2008, on the basis of water types' surface and potential gradient of confinement from sea inlets to inner areas, 42 sampling sites were selected for the macrozoobenthos monitoring.

163 taxa were identified, of which 142 were determined to species level. Polychaetes were, by far, the dominant group in each water type, followed by molluscs, crustaceans, echinoderms and other taxa. The mesohaline Lagoon sites were characterized by the disappearance of echinoderms (Fig. 2). Taking into consideration the number of taxa, Shannon-Wiener and Margalef indexes, a clear decreasing gradient from euhaline to mesohaline basins was significant, whereas abundance did not show any gradient. Three characteristics species of paralic environments (*sensu* Guélorget & Perthuisot, 1992) and euryhaline and eurythermal biocenosis (LEE) (*sensu* Pérès & Picard, 1964) were found in most of the sampling sites: the bivalve *Abra segmentum*, the nereid polychaet *Hediste diversicolor* and the spionid polychaet *Streblospio shrubsolii*. These species represented at least 60% of the relative abundance in the inner zones, where typical marine species cannot survive, with the exception of those which are able to tolerate wide amplitude of chemical and physical parameters, such as polychaetes belonging to Capitellidae and Spionidae families (for further details see Bettoso *et al*., 2010).

Thus, it can be stated that salinity represents one of the main driving force influencing the distribution of benthic organisms in the Lagoon. By applying the cluster analysis, performed by Primer software package, three different areas as a function of closeness to inlets and freshwater inputs were defined (for further details see Bettoso *et al*., 2010). In more detail, the sites close to the inlets could represent a lagoon community with marine characteristics, whereas stations nearby the inner areas as a strictly paralic community and, finally, stations showing a combination of marine and paralic properties as a mixed community. These communities could correspond to the zones II, III and IV-V defined by Guélorget & Perthuisot's benthic zonation (Guélorget & Perthuisot, 1982, 1983, 1992). Marine group resembles the zone II, as a corresponding entrance into lagoon domain with the presence of most tolerant marine species belonging to fine well sorted sands (SFBC) biocenosis and fine superficial sands

(SFS) biocenosis. Mixed group was similar to zone III with a remarkable scarcity or even disappearance of echinoderms. Vatova (1963, 1965) noticed that the holothuroid *Trachythyone elongata* is the only one able to withstand sudden salinity changes. Finally, the paralic group resembled zone IV, because of the total disappearance of most tolerant marine species, such as echinoderms, and an absolute dominance of strictly paralic species such as *A. segmentum*, *Cerastoderma glaucum* and *H. diversicolor*. In some limited areas paralic group resembled also to zone V because of the presence of chironomids larvae (Bettoso *et al*., 2010).

Fish fauna

41 fish species were recorded (Tab. 1). The mesohaline Lagoon showed the highest number of species. This was due to the concomitant presence of the typical estuarine, freshwater and juveniles of marine migrant species, such as *Engraulis encrasicolus*, *Sardina pilchardus*, *Solea solea*, *Sparus aurata* and *Platichthys flesus*. Moreover, in this area were normally found some important protected species listed in the Habitats Directive, such as *Pomatoschistus canestrinii*, *Knipowitschia panizzae* and *Aphanius fasciatus* (Fig. 3). In particular, *P. canestrinii* was almost exclusive of the most confined area of Marano's basin, where salinity ranges between 5 to 20 and the sedimentary habitat is without vegetation, as observed by Gandolfi *et al*. (1982) and Franco *et al*. (2005). This endemic species of the Adriatic Sea (Miller, 1986) was recorded in both lagoon and estuarine basins from Monfalcone to the Po River mouth (Gandolfi *et al*., 1982). Moreover, it was found in the Jadro estuary (Kolombatović, 1891), at the mouth of Mirna and Raša Rivers in the Istria peninsula, but its presence was still not recorded in the transitional environments of Slovenia (Lipej *et al*., 2006).

K. panizzae was usually recorded in the mesohaline water types and in the polyhaline too. However, the identification of this species must be clarified because it is no longer possible to distinguish exactly *Knipowitschia caucasica* and *K. panizzae*; thus the taxonomic status of these species has to be still questioned (Kovačić, 2008).

A. fasciatus is a typical euryhaline fish species. It inhabits the brackish environment, lagoons, estuaries and salina, rarely it can be found in freshwater habitats (Li-

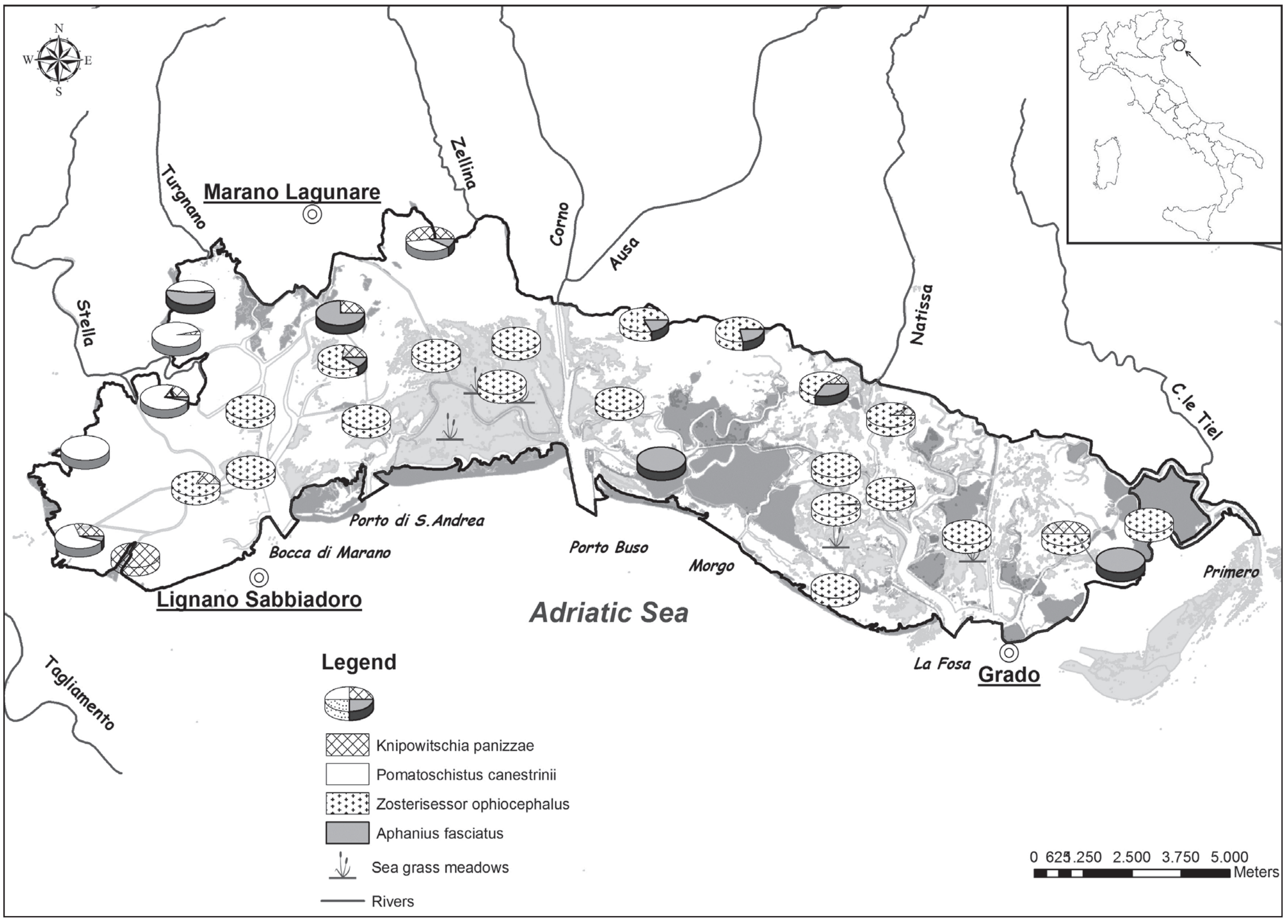

Fig. 3: Distribution of sensitive fish species in the Marano and Grado Lagoon.
Sl. 3: Porazdelitev občutljivih ribjih vrst v Gradeški in Maranski laguni

pej *et al.*, 2006). Due to its euryhaline characteristics, this species was constantly recorded in each water type of the Lagoon and it is very abundant in the Val Cavanata, a dismissed fish farm located between the Lagoon of Grado and the Isonzo River mouth.

Finally, according to the Annex II of Habitat Directive the grass goby (*Zosterisessor ophiocephalus*) is not included in the list of endangered or threatened species, but it can be considered as a fundamental component of the typical lagoon resident fish species. Within the Lagoon *Z. ophiocephalus* was normally recorded in the euhaline and polyhaline water type, mainly where sea grass meadows prevail (Fig. 3).

Fishery and aquaculture

The Lagoon hosts the two most important fisheries ports of the Region Friuli Venezia Giulia: Marano Lagunare and Grado. Taking into consideration the number of vessels, they represent almost 80% of the fisheries fleet of the region (Sladonja *et al.*, 2011). Fishermen operate at sea by trawling, seine, hydraulic dredge for bivalves (mainly *Chamelea gallina*, *Callista chione* and *Ensis minor*), trammel and gill nets, longlines, fish traps adapted to catch cuttlefish (*Sepia officinalis*) and mantis (*Squilla mantis*). Most of fishermen in Marano Lagunare work both at sea and lagoon and mainly employ the fyke nets (locally named “cogoli”), a fisheries method linked to the tidal regime (Sladonja *et al.*, 2011).

The sand smelt *Atherina boyeri* represents the target species caught by fyke nets. In terms of abundance this species represents about 75% of the total catches in both Marano and Grado basins, followed by flounder (*Platichthys flesus*) and the Baltic prawn (*Palaemon adspersus*) (Fig. 4). The brown shrimp (*Crangon crangon*) is mainly caught in the inner areas of Marano basin during the early autumn season. In the last 25 years the fisheries catches data reported from the Marano Lagoon fish market showed a general decrease especially for the most important lagoon resources such as eel (*Anguilla anguilla*), flounder, sand smelt, grass goby and crustacean (*P. adspersus*, *C. crangon* and *Carcinus aestuarii*) (Zentilin, pers. comm.). This decrease was more noticeable from the end of 80′ and beginning of 90′, because of the Manila clam (*V. philippinarum*) appearance. This species was introduced in 1986 for aquaculture purposes in the Marano basin. Due to its spreading, massive abundance, the easiness of harvesting and overall the considerable market of this resource, it led to a consistent abandonment of traditional fishery. Nowadays, the fishermen employed in the Marano Lagoon are 25, whereas in the Grado basin they do not reach 5 units, although in the Grado Lagoon Manila clam showed a lower spread than in the Marano one. In this way an impulsive and uncontrolled exploitation of this resource occurred in the Marano Lagoon. In particular, during autumn-winter period, an improper use of the specific rake employed for the harvesting caused remobilization of finest sediments and potential contaminants. Due to this, the use of this rake was forbidden since 2007. During 2010, 74% of the production derived from aquaculture conducted in 130 ha of surface (772 tons). In this area a multifunctional vessel is employed for harvesting, seeding and removal of oyster shells. Moreover, in order to employ and educate fishermen toward a sustainable aquaculture in the Lagoon, a new area of about 600 ha is suitable for

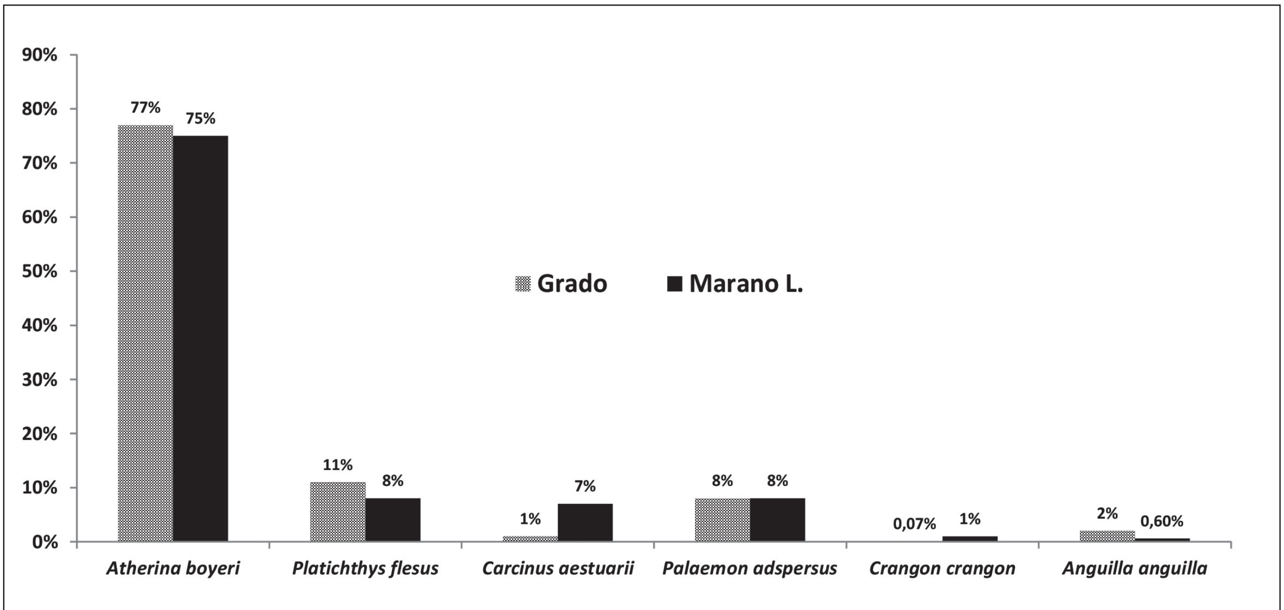

Fig. 4: Percentage catches of the main lagoon fisheries resources in Grado and Marano Lagunare (2010 data).
Sl. 4: Ulovi večjih ribolovnih virov (v odstotkih) v Gradeški in Maranski laguni (podatki iz leta 2010)

the process of oyster removal and seeding. Nowadays, after 25 years from the introduction of Manila clam, the pathway toward its sustainable aquaculture seems now possible (Sladonja *et al*., 2011).

On regard fish farm activity, this is an ancient tradition arising to 16th century in the Grado Lagoon (Sladonja *et al*., 2011). Actually there are 40 fish farms with 514.4 ha of surface water bodies employed for the production. 15 fish farms are located in Marano Lagoon, whereas 25 fish farms are located in Grado basin. Target species are sea bream (*S. aurata*) and sea bass (*Dicentrarchus labrax*) with a limited production of mullet (*Mugil* spp.). In addition, elvers of *A. anguilla* are grown in fish farms and the production of other species like shi drum (*Umbrina cirrosa*) is actually under development. Unfortunately, it is very difficult to get data of production because of the disorganization of this economic sector (Zentilin, 2008).

GRADEŠKA IN MARANSKA LAGUNA: KRATEK POVZETEK O VODNI FAVNI IN RIBOLOVNIH VIRIH

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POVZETEK

*Gradeška in Maranska laguna sta eni izmed najbolje ohranjenih mokrišč v Sredozemlju. Kljub prisotnosti kemičnih onesnaževal, zlasti živega srebra, pri oceni ekološkega stanja makrozoobentosa in ribje favne ni bilo nikakršnih težav. Porazdelitev makrozoobentoških populacij kaže jasno povezavo z gradientom slanosti, ki se ustvarja zaradi časa izmenjave z morsko vodo in vnosov sladke vode celinskega izvora. Področje predstavlja pomemben habitat za ribjo favno, še posebej za občutljive vrste, kakor tudi pomembno območje za rast mladic morskih selitvenih vrst, ki se zadržujejo predvsem v notranjem delu Maranskega bazena. Po 25 letih od vnosa filipinskih ladink (*Venerupis philippinarum*) se tukaj pot do trajnostnega ribogojstva zdi končno mogoča.*

Ključne besede: Gradeška in Maranska laguna, severni Jadran, ribja favna, makrozoobentos, ribolovnimi viri

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CHARACTERISATION OF THE NOISE EMITTED BY THE PASSAGE OF A PASSENGER CRUISE LINER IN THE VENICE LAGOON: CONCERN ABOUT POSSIBLE EFFECTS ON THE LOCAL FISH COMMUNITY

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ABSTRACT

Underwater noise emitted by a modern passenger cruise liner in the Venice lagoon under normal operational conditions was recorded in situ and analysed. This boat type causes a maximum increment of 27 dB re 1 μPa on the local background noise at 160 Hz 1/3 octave band frequency. This is of particular concern, considering that we calculated an average of five cruise passages per day in the whole month of August 2013, when this study was carried out. This increase in noise levels can cause temporary adverse responses as well as chronic effects on the typical fish population. We conclude that cruise tourism in the lagoon generates a complex variety of anthropogenic pressures acting synergistically on the aquatic community, which are difficult to predict and estimate, and therefore to mitigate.

Key words: anthropogenic noise, impact, marine ecosystem, fish community

CARATTERIZZAZIONE DEL RUMORE EMESSO DAL PASSAGGIO DI UNA NAVE DA CROCIERA NELLA LAGUNA DI VENEZIA: POSSIBILI EFFETTI SULLA COMUNITÀ ITTICA

SINTESI

È stato qui registrato e analizzato il rumore prodotto dal passaggio di una nave passeggeri durante le normali procedure di transito in laguna di Venezia. Questa imbarcazione determina un incremento di 27 dB re 1 μPa del rumore di fondo locale alla frequenza di 160 Hz (misurato in 1/3 bande d'ottava). Ciò desta particolare preoccupazione se si considera che, nel solo mese di agosto 2013, periodo in cui è stato svolto lo studio, si registra una media di 5 passaggi al giorno da parte di navi da crociera all'interno del bacino. L'aumento del rumore di fondo nell'area di transito può avere effetti temporanei o cronici rilevanti sulla comunità ittica locale. Se ne conclude che il turismo legato alle navi da crociera generi in laguna una complessa varietà di pressioni antropiche che agiscono in maniera sinergica sulla comunità acquatica e i cui effetti sono difficili da valutare e predire e, quindi, da mitigare.

Parole chiave: rumore di origine antropica, impatto, ecosistema marino, comunità ittica

INTRODUCTION

Modern extensive passenger cruise traffic is the result of a globalized tourism market with increased passenger capacity and luxury facilities (Dwyer & Forsyth, 1998). The quantification of the environmental impacts of this type of ship traffic is not an easy task to address (Dwyer *et al.,* 2004). Operational impacts involve air and water pollution and other impacts such as the physical damage of the marine ecosystem. As a result, the International Convention for the Prevention of Pollution from Ships (MARPOL) was introduced in 1973 and since updated; it aims to prevent marine environmental pollution generated from operational or accidental aspects of ships' traffic. Even if ship noise has only recently been recognized as a threat for the marine environment (Jasny *et al.,* 2005; Slabeekoorn *et al.,* 2010), in coastal regions, where ship noise may dominate the low frequency bandwidth of the underwater soundscape (Hildebrand, 2009), it is now evident that it represents a form of chronic and constant pollution (Tasker *et al.,* 2010). Ship noise pollution is considered one of the major factors affecting habitat quality for marine organisms (National Research Council, 2005), having the potential to interfere with the ability of marine animals to communicate and to interpret acoustic cues in their environment (Myberg, 1990; Jasny *et al.,* 2005; Vasconcelos *et al.,* 2007; Slabbekoorn *et al.,* 2010).

This is of particular concern in ecologically important areas, such as the Venice lagoon (Italy), situated in the NW part of the Adriatic Sea. Although the Venice lagoon has been recognized as a Special Protection Area (IT3250046, 79/409/CEE, DGP n. 441/2007) and it has have been established as a World Heritage Site by UNESCO in 1987 thanks to the presence of several different and important ecosystems, the mainland harbour of Marghera in the Venice lagoon is one of the widest and most complex industrial and shipping areas in Europe (Regione Veneto, 2010). More recently, Bolgan *et al.* (2013) have reported for the first time a consistent underwater noise pollution in the Venice lagoon, likely due to the intense merchant and passenger ship traffic characterising this lagoon. The same authors have also suggested that the passenger cruises are one of the major sources of local underwater noise (Bolgan *et al.,* 2013) but this noise source remains undescribed. The aim of the present paper is to describe the spectral characteristics of the noise emitted by a modern passenger cruise liner transiting in the Venice lagoon under normal operational conditions, *i.e.* in the presence of a tug boat and a pilot boat, and recorded *in situ* at the closest distance achievable.

MATERIALS AND METHODS

In order to estimate the intensity of the passenger cruises traffic in the lagoon, the number of passenger cruise passages along the whole month of August was counted (the data have been obtained from http://www.vtp.it/), calculating the average number of passages per day.

The noise of a passenger cruise of 250 meters (MSC Armonia; MMSI: 357281000), as well as the local background noise, were recorded on August, 23th, 2013 at 19 p.m. in the Lido tide inlet (Fig. 1). The recording was performed from a 7.5 m open boat for a total of 5 minutes. Ships positions were located using the Automatic Identification System (AIS; obtained from http://marinetraffic.com). The ship was moving at about 6 knots along the inlet, at the same speed used inside the Venice lagoon; a pilot and a tug boats were moving close to the ship, as well a speed boat. The inlet consists into a channel that connects the North Adriatic Sea with the Venice lagoon: it is about 900 m wide, about 3.5 km long and it is characterized by a maximum depth of 20 m.

The noise was recorded at a distance of 50 meters, which is the closest safe distance achievable, by lowering a pre-amplified Reson TC4032 hydrophone (sensitivity -170 dB re 1 V/μPa, frequency range 5 Hz - 120 kHz) to four metres depth (bottom depth eight metres), connected to a portable micro recorder (Zoom H1) generating WAV files (sampling rate 44.1 kHz, 16 bit). Pri-

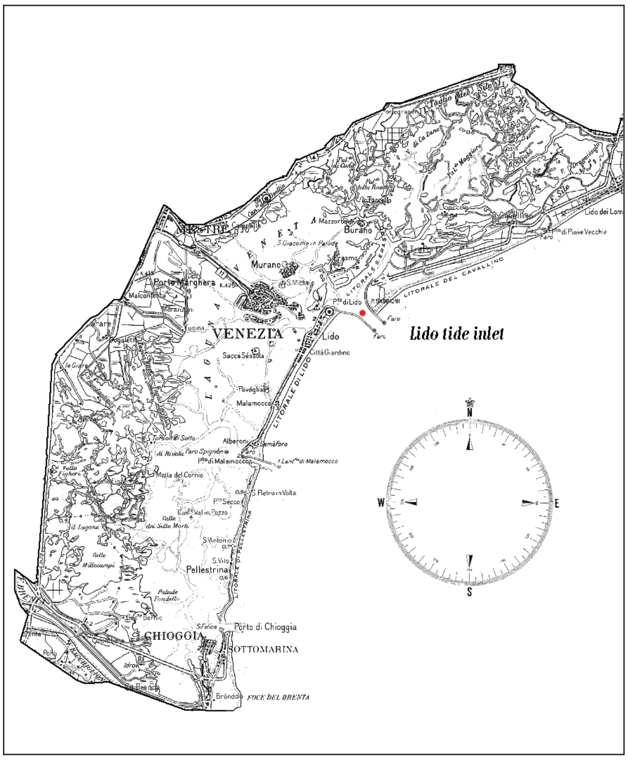

Fig. 1: Map showing the Venice lagoon with particular reference to the recording position (dot) in the Lido tidal inlet.
Sl. 1: Zemljevid Beneške lagune s posebej prikazano merilno lokacijo (pika) v dostopni ožini ob Lidu

or to the recording the signal was calibrated using a generator of pure waves of known voltage. Sampling was carried out with a sea state of less than 2 on Douglas scale and wind speed less than one metre per second; water temperature was 24.5 °C.

Data were analysed using Adobe Audition 3.0 software by auditory and visual assessment of the spectrograms (sampling rate 44.1 kHz, 16 bit). They were subsequently analysed for the 1/3 octave band standard centre frequencies in terms of instantaneous Sound Pressure Level (SPL, L-weighted, 10 Hz - 20 kHz, RMS fast) by using SPECTRA Plus 5.0 software calibrated with a signal of 100 mV RMS @1 kHz (sensitivity -170 dB re 1V/ μPa); the equivalent continuous sound pressure levels (hereafter 'L_{Leq}') were further calculated averaging the SPL over the sample period of five minutes. One assumption of this calculation is that the source is moving away at a given speed and the receiver remains stationary over the integration time.

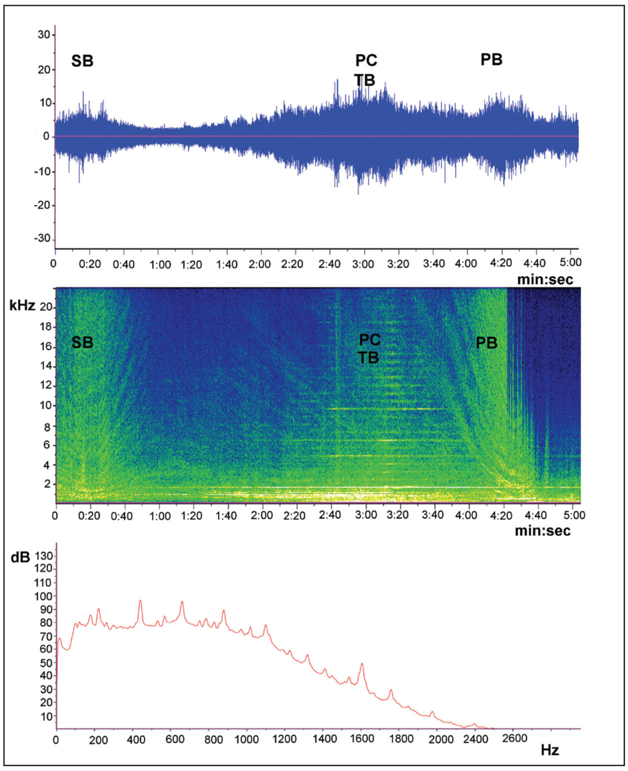

Fig. 2: Oscillogram (top), spectrogram (centre) and power spectrum (bottom) of the noise emitted from a passenger cruise liner crossing the Lido tidal inlet. A five second time period has been chosen for calculating the noise spectra (from 2:45 to 2:50 of the recording). Filter bandwidth 10 Hz, sampling frequency 44.1 KHz, 50% overlap, window Blackman Harris. SB - speed boat, PC - passenger cruise, TB - tug boat, PB - pilot boat.
Sl. 2: Oscilogram (zgoraj), spektrogram (v sredini) in spekter moči (spodaj) hrupa, ki ga oddaja potniška križarka pri prečkanju dostopne ožine pri Lidu. Za računanje spektra hrupa smo izbrali 5-sekundni interval (od 2:45 do 2:50 posnetka). Pasovna širina filtra 10 Hz, frekvenca vzorčenja 44,1 KHz, 50% prekrivanje, okno Blackman Harris. SB – gliser, PC - potniška križarka, TB – vlačilec, PB - pilotski čoln

RESULTS

During August 2013 a total of 98 passenger cruise ships have crossed the Venice lagoon (for a mean of three ships per day, min = 0, max = 7, SD = 2) for a total of 148 passages through the Lido tide inlet (for a mean of five passages per day, min = 0, max = 11, SD = 3).

The passage of the recorded passenger cruise ship produces an underwater noise with peak acoustic energy below 1600 Hz and with two peak frequencies at about 450 and 645 Hz. Also it should be noted that at 200 Hz the amplitude is around 8 dB below the peaks (Fig. 2).

From the spectrogram and the oscillogram represented in the Figure 2, the presence of different noise sources can be identified, *e.g.* a speed boat with outboard motor (around 0.20 min in the figures), followed by the passenger cruise liner and the tug boats and at the end the pilot boat; in addition, five harmonics are detectable when the passenger cruise liner was closest to the hydrophone, about 3:20 min into the recording. Figure 3 shows the mean 1/3 octave bands levels of the noise made by the passenger cruise liner's passage compared to the local background level.

The calculated L_{Leq} (five min) related to the passenger cruise liner's passage under normal operation conditions is 143 dB re 1 μPa whereas the L_{Leq} for the local background noise is 136 dB re 1 uPa; the maximum increment due to the cruise passage is located at 160 Hz and it is equal to 27 dB re 1 uPa.

DISCUSSION

The Venice lagoon stretches along the Adriatic Sea coastline and is separated from the sea by two long islands with three main tide inlets, through which the water exchange is driven by wind and tidal currents (Regione Veneto, 2010). Different shipping pressures characterize the tide inlets. Most ships transiting through the Lido inlet are passenger ships (86% of the total), and this type of marine traffic is strongly affected by seasonality, with the highest pressure during summer (Ministero delle Infrastrutture e dei Trasporti Magistrato alle Acque di Venezia 2007; Bolgan *et al.*, 2013). The average five cruise passages per day calculated in the whole month of August is of particular concern when considering that the cruise tourism, according to the present paper, encompasses a significant portion of the local background noise. Although these *in situ* recordings don't satisfy all ANSI/ASA measurement of under-

water ship noise guidelines (S12.64-2009/Part, American National Standard Institute, 2009), mainly due to the intrinsic characteristics of the recording site, the L_{Leq} value presented here provides a good estimation of the noise levels produced by the passage of the passenger cruise liners during operational conditions (*i.e.* in presence of tug and pilot boats) in the inlet. In addition, the fact that noise recordings were carried out in the tide inlet and not inside the lagoon could raise possible concern about the generalization of the present measurements. The tidal inlet has different topography and depth from the lagoon (14-15 m *vs.* an average of 1 m depth; Guerzoni & Tagliapietra, 2006) and sound propagation in shallow water is determined by many factors, such as the type of substratum, the surface boundary condition, the relationship between depth and frequency, the bottom slope, and the temperature and salinity gradient (Forrest *et al.*, 1993). Although differences are possible due to the variability of such factors, it's important to stress that the passenger liners move into the lagoon exclusively via appropriate navigation channels with similar depth and substrate (ranging from sand to muddy bottom) to the tidal inlets (Guerzoni & Tagliapietra, 2006). As result the spectral (frequency) and intensity (amplitude) content of the sounds recorded in the tidal inlet can be a good estimate of the noise created by the passenger cruise liner; this conclusion is supported by the data recorded by Bolgan *et al.* (in press) in the city of Venice.

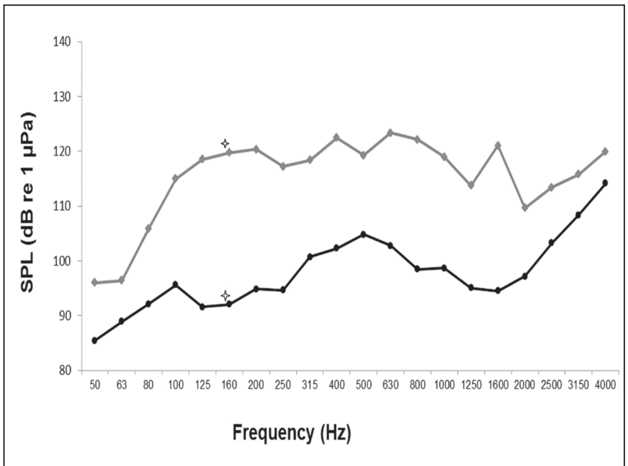

Fig. 3: 1/3 octave band Sound Pressure Level spectra (x-axis in logarithmic scale, 10 Hz – 4 kHz) of the noise produced by a passenger cruise liner under normal operational conditions (line with diamonds) compared to the local background noise level (line with dots) (sampling frequency 44.1 kHz). The frequency in which the passenger cruise causes the maximum increase in the background SPL level is depicted with stars.
Sl. 3: Frekvenčni pas 1/3 oktave ravni zvočnega tlaka (os x na logaritemski lestvici, 10 Hz – 4 kHz) hrupa, ki ga pri normalnih pogojih obratovanja povzroča potniška križarka (črta z rombi) v primerjavi z ravnijo okoljskega hrupa (črta s krogci) (frekvenca vzorčenja 44,1 kHz). Prikazana je frekvenca (zvezdici), pri kateri potniška križarka povzroči največje povišanje ravni zvočnega tlaka v okolici.

Specifically, the noise increase caused by the liner is particularly relevant (higher than 10 dB re 1 µPa) between 80 and 2500 Hz 1/3 octave band level, matching the hearing frequency range of most fish (Nedwell *et al.*, 2004) as well as of other marine vertebrates, as the loggerhead turtle *Caretta caretta* (Ketten, 2008) or invertebrates, as squids (Mooney *et al.,* 2010).

The here reported noise levels are particularly critical for marine animals that have limited mobility, considering that they will be affected by noise for about 20 min for each liner's passage (the inlets are about 3.5 km long and the ship speed is about six knots). The same is true for highly mobile animals that show site fidelity during reproduction *e.g. Sciaena umbra*, a protected vocal fish species that has been detected in the Lido tide inlet during its reproductive season (Picciulin *et al.,* 2013). The same consideration is also applicable to the other typical Mediterranean rocky reef communities that colonise the rocky substrate of the Venetian littoral zone (Cecconi *et al.,* 2008; Fiorin *et al.,* 2008; Rismondo *et al.,* 2008; Ministero delle Infrastrutture e dei Trasporti Magistrato alle Acque di Venezia, 2009; Riccato *et al.,* 2009).

Although the temporary adverse responses to vessel noise (*i.e.* changes in behaviour, displacement, decreasing in hearing sensitivity, enhancing of stress hormones) and the masking effect of this type of pollution on acoustic communication have been widely reported for several vertebrate species (Świerzowski, 1999; Scholik & Yan, 2002; Amoser *et al.,* 2004; De Robertis *et al.,* 2010; Engas *et al.,* 2011), the chronic effects of vessel noise on fish have received less attention to date; Picciulin *et al.* (2012) demonstrated that *S. umbra* mean pulse rate increased over multiple boat passages, likely as a form of vocal compensation. On the other hand Spiga *et al.* (2012a, b) did not find any influence of long-term vessel noise exposure on the growth and nutrition of other Sciaenidae species, but behavioural changes have been noticed. Despite this, there may be further long-term consequences due to chronic exposure to vessel noise. Vessel noise pollution can also indirectly affect animals through changes in the accessibility to prey, which may suffer the adverse effects of acoustic pollution: a detrimental effect on marine fish larvae exposed to underwater noise pollution has been recently demonstrated by Aguilar de Soto *et al.* (2013) and Bolle *et al.* (in press). This effect can be important considering that the lagoon is the ideal place for the growth of juveniles of many marine species (Regione Veneto, 2010).

Considering that ship traffic has also been demonstrated to affect both the hydro-morphology and the

re-suspension of sediments (Regione Veneto, 2010), we can conclude that the presence of cruise tourism in the lagoon generates a complex variety of anthropogenic pressures acting synergistically on the aquatic community, which are difficult to predict and estimate, and therefore to mitigate.

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OPREDELITEV HRUPA, KI GA POVZROČA PREHOD POTNIŠKE KRIŽARKE V BENEŠKI LAGUNI: ZASKRBLJENOST ZARADI MOŽNIH VPLIVOV NA LOKALNO RIBJO ZDRUŽBO

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POVZETEK

Na mestu izvora smo posneli in kasneje analizirali podvodni hrup, ki ga v Beneški laguni pri normalnih obratovalnih pogojih odda moderna potniška ladja za križarjenje. Ta vrsta plovila za maksimalno 27 dB re 1 µPa poviša okoljski hrup pri 160 Hz frekvenčnega pasu 1/3 oktave. To je še posebej zaskrbljujoče, saj smo za avgust 2013, ko smo izvajali to raziskavo, izračunali povprečje petih prehodov tovrstnih ladij na dan. Zvišana raven hrupa lahko povzroči začasne negativne odzive, lahko pa tudi kronično vpliva na tipično ribjo populacijo. Iz tega lahko sklenemo, da križarski turizem v laguni povzroča zapleten sklop antropogenih pritiskov, ki v sinergiji učinkujejo na vodne združbe in jih je težko predvideti ter oceniti, posledično pa tudi težko omiliti.

Ključne besede: antropogeni hrup, vpliv, morski ekosistem, ribje združbe

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NOTES ON INVERTEBRATES PREYED BY SHREWS (MAMMALIA: INSECTIVORA: SORICIDAE) IN SLOVENIA

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ABSTRACT

Until recently in Slovenia, the presence of invertebrates in the shrew diet had not been investigated. Here we present a list of invertebrates and other ingested items in five shrew species: Sorex alpinus, S. araneus, S. minutus, Crocidura suaveolens *and* Neomys fodiens *in Slovenia. These shrews fed mostly on arthropods and earthworms. Among the arthropods, Araneae, Opiliones, Lithobiomorpha and Insecta were found. Oniscoidea and Diplopoda, generally abundant in the shrews' habitats, were not found. Among the identified species,* Amaurobius ferox, Mitopus morio, Aptinus bombarda *and* Apterygida media *were the most common prey.*

Key words: shrew prey, Soricidae, Arthropoda, Slovenia

NOTE SU INVERTEBRATI PREDATI DA TOPORAGNI (MAMMALIA: INSECTIVORA: SORICIDAE) IN SLOVENIA

SINTESI

Solo recentemente è stata indagata la presenza di invertebrati nella dieta del toporagno in Slovenia. Gli autori presentano l'elenco degli invertebrati e di altri oggetti ingeriti da cinque specie di toporagno: Sorex alpinus, S. araneus, S. minutus, Crocidura suaveolens e Neomys fodiens *in Slovenia. Questi toporagni si nutrono per lo più di artropodi e lombrichi. Tra gli artropodi sono stati trovati rappresentanti di ragni (Araneae), opilionidi (Opiliones), centopiedi (Lithobiomorpha) e insetti (Insecta). Non sono state rinvenute invece specie di onisicidi (Oniscoidea) e diplopodi (Diplopoda), generalmente abbondanti negli habitat dei toporagni. Tra le specie identificate le prede più comuni sono:* Amaurobius ferox, Mitopus morio, Aptinus bombarda e Apterygida media.

Parole chiave: prede di toporagni, Soricidae, Arthropoda, Slovenia

INTRODUCTION

Shrews (Soricidae) are small insectivorous mammals that occupy relatively small territories, are active many times a day throughout the year and are opportunistic feeders (Churchfield, 1994; Churchfield & Rychlik, 2006). They prey mostly on invertebrates, like arthropods, lumbricids, slugs and others. So far, their prey has rarely been determined on the species level (Denneman, 1990; Mitov, 1995; Novak *et al.,* 2006; Klenovšek *et al.,* 2013), as studies on the shrew diet have focused mostly on the quantity of the prey consumed. Such papers usually list families and higher taxa, along with the prey body length classes (*e.g.,* Churchfield, 1994; Churchfield & Rychlik, 2006) or volume (Whitaker & Ruckdeschel, 2006), which are indicative of the prey body mass or its energy value to the predator. Besides consuming them, shrews cause injuries to living invertebrates, like the litter-dwelling opilionid *Trogulus nepaeformis*, where the legs of up to one-third of individuals in some populations have been damaged (Novak *et al.,* 2006). Such knowledge highlights the complexity of the impact of shrews on the syntopic invertebrates. Although shrews are opportunistic feeders, they are known to avoid Diplopoda (*e.g.,* Churchfield & Rychlik, 2006), which are abundant in most habitats, and shrews presumably do not eat invertebrates living above the ground (Churchfield, 2002). Thus, they are not expected to eat all invertebrates within a territory, and in this way exert an unequal impact on the invertebrate population.

The aim of this paper is to present a list of invertebrate prey species and other consumed material based on food remnants found in the stomachs of five shrew species in Slovenia (*Sorex alpinus, S. araneus, S. minutus, Crocidura suaveolens* and *Neomys fodiens*). Selected photographs of recognized prey and other ingested items – such as those provided for neuropterans (Devetak & Duelli, 2007) – are included as indispensable for the recognition and determination of prey species. We also discuss the role of some invertebrate species as the shrews' prey and the role of shrews as natural predators of some invertebrates in Slovenia.

MATERIAL AND METHODS

In total, the stomach contents of 204 shrews belonging to five species were considered: 124 specimens of *Sorex araneus* Linnaeus, 1758, 60 specimens of *S. minutus* Linnaeus, 1766, 18 specimens of *S. alpinus* Schinz, 1837, one specimen of *Crocidura suaveolens* (Pallas, 1811) and one specimen of *Neomys fodiens* (Pennant, 1771). Most of the stomachs accrued from investigations on Mt. Snežnik and Mts. Peca, Smrekovec and Olševa (in the following: the Koroška Mts.), in which small mammals and invertebrates were systematically sampled (Trilar, 1991; Kos *et al.,* 2000; Drovenik, 2001; Janžekovič & Čas, 2001). Nearly all of these stomachs were used for a trophic niches comparison of the three syntopic *Sorex* species in a montane habitat (Klenovšek *et al.,* 2013). The rest of the shrews were from other localities (Tab. 1).

The stomachs were dissected, and their contents transposed into 70% ethanol and inspected for major food remnants. Afterwards, the contents were heated in 10% NaOH at 80 °C for 4 hrs (Sommer & Sommer, 1997) to dissolve soft tissues. Undissolved remnants, like chitinous, cellulose and other similar particles, were examined under a Nikon Eclipse E800 compound microscope with a mounted digital Net camera DN100, and processed with Eclipse Net software. The photographed prey remains were identified by comparison to invertebrate specimens collected at the same time and in the same locality as the shrews. Most frequently small fragments of antennae, legs, elytrae, heads, chelicerae etc. were found, which enabled unambiguous comparison and determination.

RESULTS

In 204 stomachs of five shrew species, a total of 180 animal prey items from 21 taxa were identified. In addition, we found soil and wood particles, rootlets and animal prey remnants, which could not be identified. The list of food items found is presented in Table 2, and selected

Tab. 1: Locality, altitude, collection date, shrew species and the number of specimens investigated.
Tab. 1: Lokaliteta, nadmorska višina, datum ulova, vrsta in število pregledanih osebkov

Locality, altitude	Date	Shrew species	No of individuals
Mt. Snežnik, 1150–1350 m	1988–1990	*Sorex araneus*	65
		S. alpinus	1
Mts. Peca, Smrekovec and Olševa, 1030–1500 m	MayOctober 1999–2000	*S. araneus*	59
		S. minutus	58
		S. alpinus	14
Idrija, 520 m	13. 7. 2001	*S. alpinus*	3
Postojna, 530 m	13. 7. 2001	*S. minutus*	2
Dragonja, 60 m	13. 7. 2001	*Crocidura suaveolens*	1
Slovenj Gradec, 430 m	23. 6. 2000	*Neomys fodiens*	1

Tab. 2: List of invertebrates and plant material found in the stomachs of five shrew species.
Tab. 2: Seznam nevretenčarjev in rastlinskega materiala, najdenega v želodcih petih vrst rovk

Food items			***Sorex araneus* (n=124)**	***S. minutes* (n=60)**	***S. alpines* (n=18)**	***Crocidura suaveolens* (n=1)**	***Neomys fodiens* (n=1)**
Wood particles			+		+		
Rootlets			+				
Prey							
Higher taxon	Family	Species					
Gastropoda indet. (slugs)			+				
Lumbricidae indet.			+	+	+		
Araneae indet.			+	+	+		+
	Amaurobiidae						
		Amaurobius ferox (Walckenaer 1830)	+	+	+		
Opiliones							
	Phalangiidae						
		Lacinius ephippiatus (C. L. Koch 1835)	+				
		Opilio dinaricus Šilhavý 1938				+	
		Rilena triangularis (Herbst 1799)		+			
		Mitopus morio (Fabricius 1799)	+	+	+		
	Trogulidae						
		Trogulus nepaeformis (Scopoli 1763)	+				
Lithobiomorpha indet.			+		+		
Insecta indet.			+	+			
Dermaptera							
	Forficulidae	*Apterygida media* (Hagenbach 1822)	+	+	+		
Coleoptera indet.			+	+	+		
	Carabidae		+				
		Aptinus (*Aptinus*) *bombarda* (Illiger 1800)	+	+	+		
		Carabus (*Megadontus*) *violaceus* Linnaeus 1758	+				
		Nebria dahlii (Duftschmid 1812)	+				
	Staphylinidae	*Philonthus* sp.	+				
	Curculionidae	*Tropiphorus elevatus* (Herbst 1795)	+				
	Pselaphidae			+			
Hymenoptera							
	Myrmicidae		+				
Diptera							
	Cecidomyiidae	*Mikiola fagi* (Hartig 1839)	+				

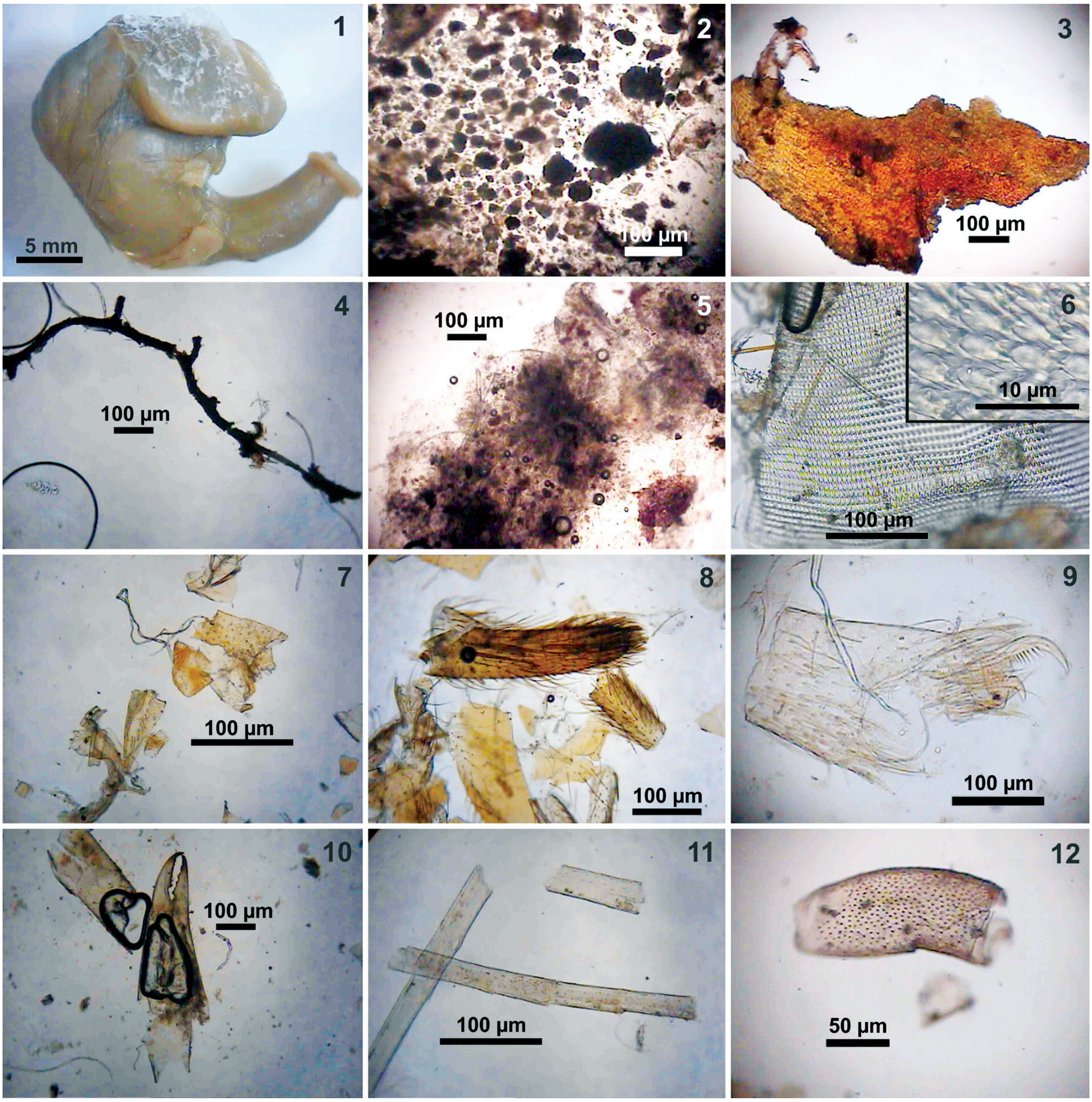

PLATE I: Shrew stomach and selected remnants of food items. Fig. 1: stomach of *Sorex araneus****; Fig. 2: soil particles; Fig. 3: wood particle; Fig. 4: rootlet; Fig. 5: earthworm residuals; Fig. 6: slug radula; Fig. 7: arthropod chitinous remains; Fig. 8: spider remains; Fig. 9:*** *Amaurobius ferox* ***tarsus; Fig. 10:*** *Rilaena trinagularis* ***chelicerae; Fig. 11:*** *Lacinius ephippiatus* ***legs; Fig. 12:*** *Mitopus morio* ***pedipalpal patella.***
TABLA I: Želodec rovke in izbrani preostanki hrane. Sl. 1: želodec vrste *Sorex araneus****; Sl. 2: delci prsti; Sl. 3: delci lesa; Sl. 4: koreninica; Sl. 5: ostanki deževnika; Sl. 6: strgača polža; Sl. 7: hitinski ostanki členonožca; Sl. 8: ostanki pajka; Sl. 9: tarzus vrste*** *Amaurobius ferox****; Sl. 10: helicera vrste*** *Rilaena trinagularis****; Sl. 11: noge vrste*** *Lacinius ephippiatus****; Sl. 12: patela pedipalpa vrste*** *Mitopus morio*

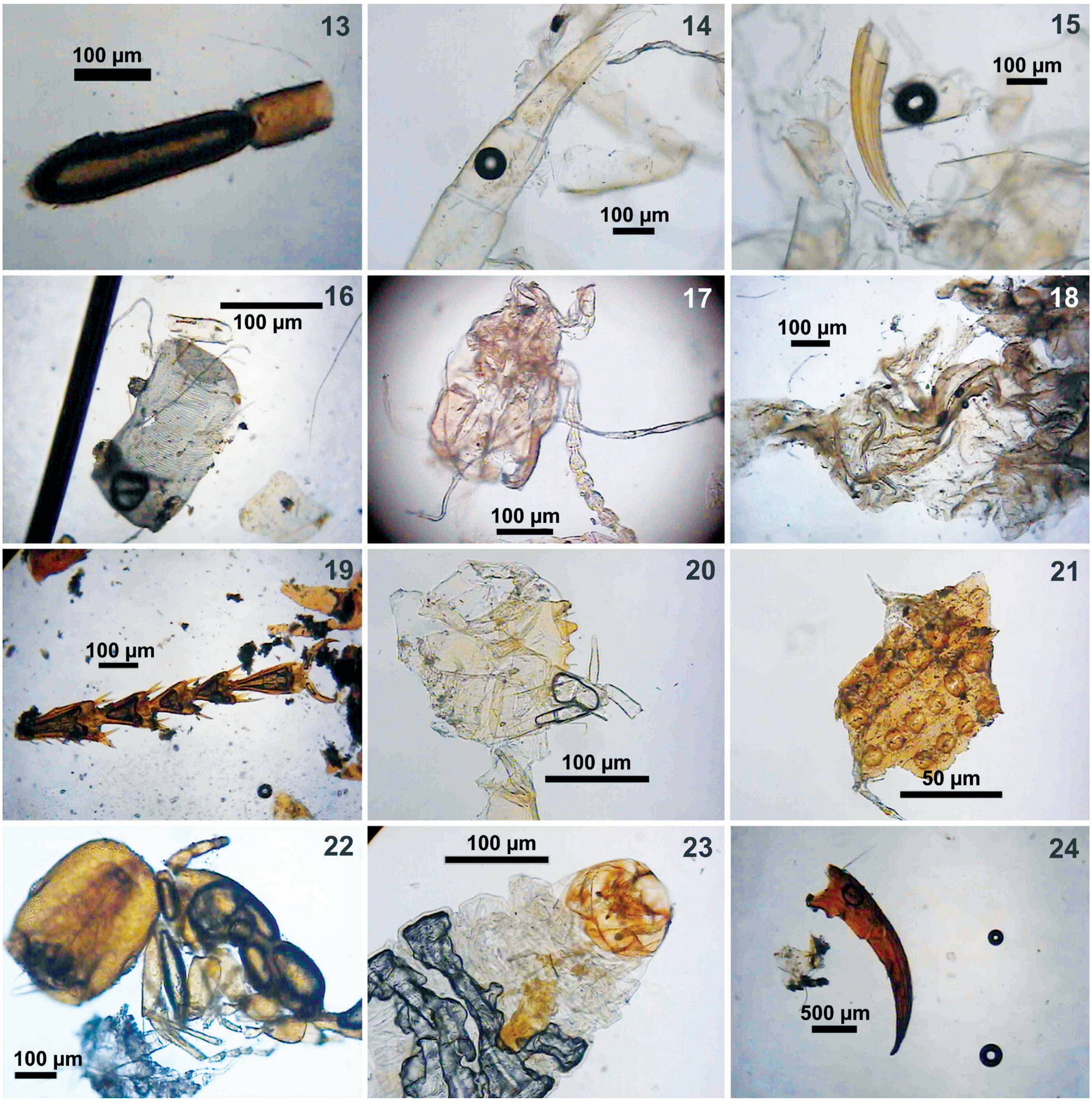

PLATE II: Selected remnants of food items. Fig. 13: *Trogulus nepaeformis* ***2nd leg tarsus; Fig. 14: leg of lithobiomorphous; Fig. 15: lithobiomorphous maxillipede; Fig. 16: insect trachea; Fig. 17:*** *Aptinus bombarda* ***head; Fig. 18:*** *Carabus violaceus* ***proventricle chitinous inner covering; Fig. 19:*** *Nebria dahli* ***tarsus; Fig. 20:*** *Tropiphorus elevatus* ***maxilla; Fig. 21:*** *T. elevatus* ***fore-wing; Fig. 22: Myrmicid ant; Fig. 23:*** *Michiola fagi* ***larva; Fig. 24:*** *Apterygida media* ***cercus.***
TABLA II: Izbrani preostanki hrane. Sl. 13: vrsta *Trogulus nepaeformis* ***– tarzus druge noge; Sl. 14: noga strige; Sl. 15: maksiliped strige; Sl. 16: traheja žuželke; Sl. 17: glava vrste*** *Aptinus bombarda****; Sl. 18: hitinska notranja plast proventrikla vrste*** *Carabus violaceus****; Sl. 19: tarzus vrste*** *Nebria dahli****; Sl. 20: maksila vrste*** *Tropiphorus elevatus****; Sl. 21: prednje krilo vrste*** *T. elevatus****; Sl. 22: mirmicidna mravlja; Sl. 23: larva vrste*** *Michiola fagi****; Sl. 24: cerk vrste*** *Apterygida media*

photos of ingested items in Plates I and II. The majority of the preyed animals belonged to arthropods, and among the others we recognized slug and earthworm remnants. The most frequent determinable taxa were Insecta, Araneae, Lumbricidae and Opiliones, while Oniscoidea and Diplopoda were not found. Among the insects, Coleoptera were the most frequent prey.

DISCUSSION

Shrews are opportunistic feeders that forage on various soil-, litter-, and water-dwelling invertebrates and small vertebrates (Churchfield & Rychlik, 2006; Churchfield, 2008). The shrews studied in our investigation fed mostly on earthworms, spiders, harvestmen and insects. Some prey remnants were determined to the species level, a process which was time consuming, but it did yield evidence of the impact of shrew predation on particular invertebrate species. Species-level determination is also indispensible in detailed comparative analysis of the shrew diet niches (Klenovšek *et al.,* 2013).

Earthworms are usually a common shrew prey (Churchfield & Rychlik, 2006). In our study they were found in all three *Sorex* species and were probably frequently eaten because of their large size, slow movement and abundance. Oniscoidea were reported in other *Sorex* species (Churchfield, 2002), but absent in our shrews.

Another frequent prey were spiders, from which only *Amaurobius ferox* was identified to the species level. This relatively large and, in woodlands widespread, ground-dwelling spider was obviously a profitable prey.

Mitov (1995) reported on five slow moving, hygrophilous opilionid species found in 33 shrew stomachs on Vitosha Mountain, Bulgaria. Novak *et al.* (2006) reported of leg damages in the opilionid *Trogulus nepaeformis* caused by shrews. In contrast to these reports, we found relatively rapidly moving species as prey, which search for daily refuge under stones, wood, bark, and similar microhabitats on the ground. Moreover, preying on the fast moving opilionid *Opilio dinaricus*, which mostly lives in the understory, demonstrates that shrews may also influence above-ground species.

Among the Myriapoda, only Lithobiomorpha were found. Diplopoda have been reported as being avoided by shrews (Grainger & Fairley, 1978; Klenovšek *et al.*, 2013), probably on account of their scent gland exudates. Such glands are also characteristic of harvestmen, but the chemical composition of their defence compounds (*e.g.*, Raspotnig *et al.,* 2010) is obviously not as unpleasant to shrews as in Diplopoda. Beetles from the Carabidae family also produce defensive secretions, and some have been reported to be avoided by shrews (Bonacci *et al.,* 2011). Surprisingly, *Aptinus bombarda*, which produces chemical repellents and popping sounds, was commonly preyed by the *Sorex* species.

Shrews prefer more profitable prey, but abundance may influence the predation of smaller prey. They probably become habituated to its availability. This could be the case when *S. araneus* was found to be feeding extensively on relatively small *Mikiola fagi* larvae on Mt. Snežnik in 1989 when *M. fagi* appeared in abundance (Trilar, 1991). In this way, shrews importantly regulated the population of *M. fagi*.

Since invertebrates in shrews' diet have seldom been identified on the species level, we believe that such studies can valuably contribute to the understanding of the shrew's impact on particular invertebrate species.

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ZAPISKI O NEVRETENČARJIH KOT PLENU ROVK (MAMMALIA: INSECTIVORA: SORICIDAE) V SLOVENIJI

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POVZETEK

Rovke (Soricidae) so majhni žužkojedi sesalci, ki se prehranjujejo predvsem s členonožci, z deževniki, s polži in z drugimi nevretenčarji. V študijah o prehrani rovk avtorji običajno navajajo plen, določen do nivoja družin ali višjih taksonov, medtem ko je plen redko določen do vrste. V prispevku predstavljamo seznam uplenjenih vrst in druge želodčne vsebine pri petih vrstah rovk: Sorex alpinus, S. araneus, S. minutus, Crocidura suaveolens *in* Neomys fodiens *v Sloveniji. Pregledali smo vsebino želodcev 204 rovk. S primerjavo ostankov zaužitega plena z zbirko nevretenčarjev, ulovljenih skupaj z rovkami, smo prepoznali 180 osebkov plena iz 21 taksonov. Preostanke plena in drugo vsebino želodcev smo fotografirali. Rovke so jedle predvsem členonožce in deževnike. Od členonožcev so bili najpogostejši plen pajki, suhe južine, strige in žuželke ter med slednjimi hrošči. Od prepoznanih vrst so bile najpogostejše* Amaurobius ferox, Mitopus morio, Aptinus bombarda *in* Apterygida media. *Kočičev in dvojnonog, sicer pogostih v habitatih rovk, nismo našli. Rovke običajno plenijo endogejične in epigejične nevretenčarje, zato je najdba suhe južine* Opilio dinaricus*, ki živi pretežno v podrasti, nakazala, da lahko rovke vplivajo na širši razpon nevretenčarjev, kot običajno pričakujemo. Rovke se navadno hranijo z večjim plenom, a če so manjši nevretenčarji, kakršne so ličinke* Mikiola fagi*, pogosti, iščejo in jedo tudi tak plen. Raziskave prehrane rovk z identifikacijo plena do vrste lahko pomembno prispevajo k poznavanju vpliva rovk na posamezne vrste nevretenčarjev.*

Ključne besede: plen rovk, Soricidae, Arthropoda, Slovenija

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NEW RECORDS OF *ONTHOPHAGUS FURCATUS* (FABRICIUS, 1781) (COLEOPTERA: SCARABAEIDAE) IN SLOVENIA AND THE OVERVIEW OF ITS DISTRIBUTION AND OCCURRENCE IN THE NORTH-WESTERN BALKANS

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ABSTRACT

From 16 species of the genus Onthophagus *Latreille, 1802 occurring in Slovenia, 5 have not been recorded for at least 60 years. In this paper three new records of one of such species,* Onthophagus furcatus *(Fabricius, 1781), recorded at three new localities in the southern part of Slovenia (Slovenian Istria) are presented. These records expand the known range of occurrence of this species in Slovenia, as well as confirm that it is still present in the country. An overview of the distribution of this species in the north-western Balkans (Slovenia, Croatia and Bosnia and Herzegovina), altitudinal range and times of occurrence are also given. In the area of the NW Balkans,* O. furcatus *is active from April to October, mostly at altitudes below 400 m. Most records originate from the Mediterranean part of the NW Balkans, adjacent to the Adriatic Sea, while the northern records are rare and scattered.*

Key words: dung beetles, Slovenian Istria, chorological occurrence, altitudinal occurrence

NUOVE SEGNALAZIONI DI *ONTHOPHAGUS FURCATUS* (FABRICIUS, 1781) (COLEOPTERA: SCARABAEIDAE) IN SLOVENIA E REVISIONE DELLA SUA DISTRIBUZIONE E PRESENZA NEI BALCANI NORD-OCCIDENTALI

SINTESI

Delle 16 specie del genere Onthophagus *Latreille, 1802 che vivono in Slovenia, 5 non sono state rinvenute per almeno 60 anni. In questo lavoro vengono trattati tre nuovi ritrovamenti di una di queste specie,* Onthophagus furcatus *(Fabricius, 1781), segnalata per tre nuove località nella parte meridionale della Slovenia (Istria slovena). Questi dati vanno ad ampliare l'area di distribuzione della specie in Slovenia, così come confermano la sua presenza attuale nel paese. L'articolo offre una revisione della distribuzione di tale specie nei Balcani nord-occidentali (Slovenia, Croazia e Bosnia ed Erzegovina), completa di dati sull'ampiezza altitudinale e del periodo di ritrovamento. Nella zona dei Balcani nord-occidentali* O. furcatus *è attivo da aprile ad ottobre, per lo più a quote inferiori ai 400 m. La maggior parte dei ritrovamenti risale alla zona mediterranea dell'area studiata, quella adiacente al mare Adriatico, mentre i ritrovamenti settentrionali sono rari e dispersi.*

Parole chiave: scarabei stercorari, Istria slovena, presenza corologica, ampiezza altitudinale

INTRODUCTION

The dung beetle fauna of the north-western Balkans (Slovenia, Croatia and Bosnia and Herzegovina) has been surveyed by many different entomologists (*e.g.* Müller, 1902; Depoli, 1924; Novak, 1952) during the last 200 years. However, the works of Rene Mikšić, especially his monographs and identification keys for the dung beetles (Mikšić, 1958, 1962, 1965) and the catalogues of the Lamellicornia of Yugoslavia (Mikšić, 1970) were and still remain the best source of information for most countries. For example, only several recent records of dung beetles were published (*e.g.* Koren *et al.,* 2010, 2011) in Croatia after the works of Mikšić (1958, 1962, 1965, 1970, 1984), without any newer overview or checklist. In Bosnia and Herzegovina the situation is almost the same, with the exception of the recent checklist of the superfamily Scarabaeoidea (Lelo & Kašić-Lelo, 2010). However, this checklist only represents a modern update to the works of Mikšić (1970, 1984), and does not provide any new data about the dung beetle fauna of Bosnia and Herzegovina. The best situation is probably in Slovenia, where a recent overview of the superfamily Scarabaeoidea in Slovenia was published (Brelih *et al*., 2010) containing all the known literature data and data from private and museum collections, as well as distribution maps, ecology and checklists. In that overview, 16 species belonging to the genus *Onthophagus* Latreille, 1802 were listed (Brelih *et al*., 2010). It is interesting to note that five of the 16 species were not recorded in Slovenia after the year 1950, and one species was recorded only once (Brelih *et al.,* 2010). This indicates that the knowledge about the presence and distribution of this genus in Slovenia is still rather poor, and the recent occurrence of several species needs to be confirmed.

The genus *Onthophagus* Latreille, 1802 consists of about 2000 species worldwide (Tarasov & Kabakov, 2010), around 40 of which can be found in Europe (Mikšić, 1958). Members of this genus are small to middle sized coprophagous beetles, mostly inhabiting dry and sunny, open and more or less steppe or half-steppe biotopes. They can be found in a range of different kind of animal excrements, along with the other most numerous dung beetle family Aphodidae.

Ontophagus furcatus (Fabricius, 1781) is a Turanic-European-Mediterranean species, distributed in central and southern Europe, Asia Minor, Transcaucasia, the Arabian Peninsula, Iraq, Turkmenistan and Morocco (Brelih *et al*., 2010). It is a stenotope, colline species inhabiting xerothermophilous habitats (Brelih *et al*., 2010). It can be recorded on sunward oriented slopes and dry pastures, frequenting horse, cattle, human and other excrements, at times even carrion. Adults occur in dung from mid-April to the end of August, particularly in June and July.

In Slovenia, *O. furcatus* is considered to be a rare species, with no recent records, and very few older literature records (Brelih *et al*., 2010). The first mention for Slovenia originates from Siegel (1866) who cites it for the Carniola region, but without any exact localities. Mikšić (1958, 1970) mentions its occurrence in western Slovenia, possibly referring to the record of Siegel (1866). It was only several years ago when the first date – locality data were published for this species in Slovenia; for Ajdovščina (without any date), Kreplje, collected on July 1924 and Krim, 1949 (Brelih *et al*., 2010). After that, no records for this species in Slovenia were published.

The aim of this paper is to present the distribution, altitudinal and chorological occurrence of this species in the area of the north-western Balkan (Slovenia, Croatia and Bosnia and Herzegovina).

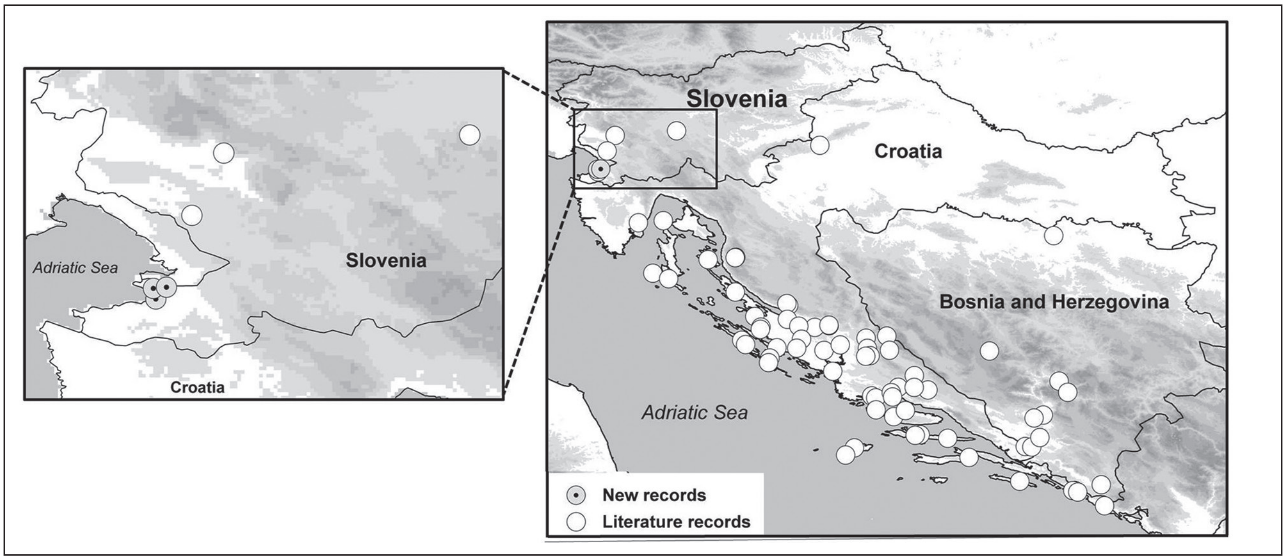

Fig. 1: Distribution of** Onthophagus furcatus **in the NW Balkan.
Sl. 1: Razširjenost vrste** Ontophagus furcatus **na SZ Balkanu

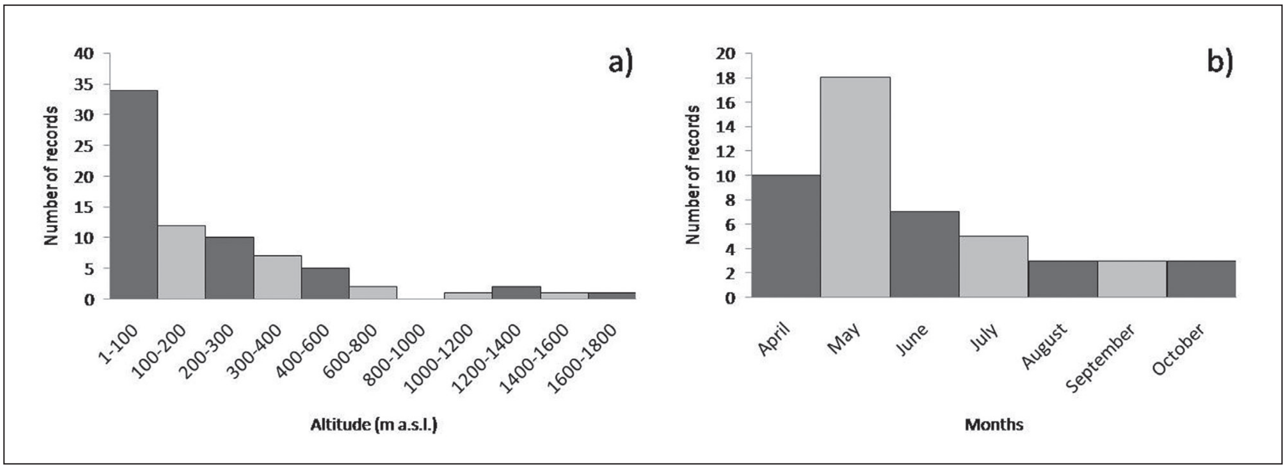

Fig. 2: Altitudinal and chorological occurrence of *O. furcatus* ***in the NW Balkans. a) Records in different altitudinal zones, and b) records in different months.***
Sl. 2: Višinsko in časovno pojavljanje *O. furcatus* ***na SZ Balkanu: a) najdbe v različnih višinskih conah in b) najdbe v različnih mesecih***

MATERIALS AND METHODS

The material mentioned here was collected by the second author during the last few decades in the territory of Slovenia. Dung beetles were collected by examination of animal excrements, and stored in the author's private collection (M. Gjerkeš collection).

Insects were sampled on the following locations:

Bonifika, between Koper and Ankaran, pasture, 1.8.1991, 45° 33′ 20.03″ N, 13° 45′ 24.13″ E, 5 m a.s.l., cow excrement, 1F;

Monte Moro, Ankaran, overgrown pasture, 19.4.2013 and 29.4.2013, 45° 34′ 46.33″ N, 13° 45′ 00.55″ E, 115 m a.s.l., goat excrement, 1M; 1M & 1F;

Elerji village, Kaštelir hill, 1.7.2013 and 28.8.2013, pasture, 45° 34′ 55.50″ N, 13° 46′ 52.23″ E, 244 m a.s.l., horse excrement, 1M; 3M & 6F.

All the material was prepared using standard methods, and identified using modern identification key (Ballerio *et al.*, 2010). To create the distribution maps, all available known literature was consulted, and a database containing all the records, dates and the altitudes of occurrence for this species was created. For Slovenia, all the records were already contained in the work of Brelih *et al.* (2010), while for Bosnia and Herzegovina data were available from the overview of Lelo & Kašić-Lelo (2010). Most data from Croatia were found in the works of Novak (1952), Novak & Etoni (1964–1965), Mikšić (1958) and Koren *et al.* (2010, 2011).

RESULTS AND DISCUSSION

Occurrence in NW Balkans

In total we were able to gather 72 records of *O. furcatus* in the north-western Balkan, and create a first distribution map for the species (Fig. 1).

In Croatia, *O. furcatus* is mostly limited to the Mediterranean region, adjacent to the Adriatic Sea, but some records for the northern part of the country also exist. Only several records exist from Bosnia and Herzegovina, which is probably due to the lack of historical and recent surveys in the country. However, it seems that it is not as common and widespread as in Croatia (T. Koren, personal communication).

In Slovenia this species is present only in the south-western part of the country, adjacent to the Croatian and Italian borders. Although all three recent records are located in close proximity to each other, they represent an extension of the known distribution range of this species in Slovenia towards the south-western part of the country, namely Slovenian Istria.

Regarding the altitudinal distribution, this species is present from sea level to high altitudes, reaching almost 1800 m a.s.l (Fig. 2). Most records are however located on the lower altitudes, showing a strong affinity of this species for lower areas which confirms the literature data (Ballerio *et al.*, 2010). Regarding the month of occurrence, *O. furcatus* is active from April to October in the north-western Balkans. Most records of this species originated in the spring time, with the highest number of records in May (N = 18) and April (N = 10).

New records from Slovenia

Historically this species was recorded on three more northerly localities and the presence of the species there needs to be confirmed in the future. Our new records of *O. furcatus* show that this species is still present in Slovenia.

Each of our new records originates from a different type of animal excrement, namely cow, horse and goat.

This means that in Slovenia this species consume different types of excrement, as it was already known from the literature (Ballerio *et al*., 2010). With that fact in mind, it is interesting that this species had been recorded only three times in the country. The reasons for such a low number of historical records could probably be found in the small number of entomologists who studied this group of dung beetles in Slovenia in the past and the present. It is possible that this species can be easily confused with similar small black *Onthophagus* species such as *Onthophagus ovatus* (Linnaeus, 1767), *Ontophagus joannae* (Goljan, 1953), *Onthophagus grossepunctatus* (Reitter, 1905) or *Onthophagus ruficapillus* (Brullé, 1832). But even for amateurs, the situation becomes fairly easy when the beetles are examined under a stereo microscope. The main difference between *O. furcatus* and the others are the outwardly curved front angles of the pronotum present in *O. furcatus*, and not present in any other similar species occurring in the area (Ballerio *et al*., 2010). It is even easier with males of this species, which have two small horns on the head, not present on the heads of any other similar species' males in the region (Fig. 3).

While the decrease of some dung beetle species is prone to occur in the future due to climate change and succession of pastures, it seems that will not be the case with *O. furcatus*, at least in western Europe. Dortel *et al*. (2013) showed that due to climate change, *O. furcatus* may be one of several species which could prosper, and become more widespread in Portugal, Spain and France. As this species is relatively common in neighbouring countries (Mikšić, 1958; Ballerio *et al*., 2010), new records are to be expected in the southern parts of Slovenia. In nearby Italy, this species is widespread and common (Ballerio *et al*., 2010) and the same is in most parts of Croatia (Mikšič, 1958). Other than *O. furcatus*, there are several other species from the same genus, as well as other dung beetle species which were not recorded in Slovenia for at least 50 years, and some are even considered extinct (Brelih *et al*., 2010). This shows that the dung beetle fauna of Slovenia is still far from well known, and further systematic surveys need to be done in the future.

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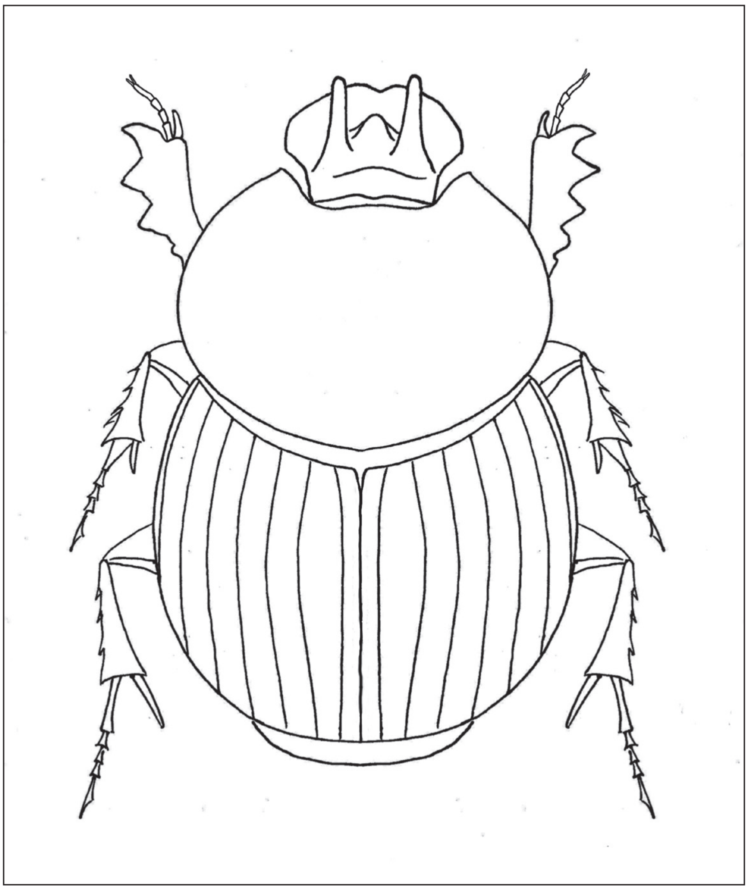

Fig. 3: Male specimen of *O. furcatus* ***from Slovenia (author: Gaja Pavliha).***
Sl. 3: Samec vrste *O. furcatus* ***iz Slovenije (avtorica: Gaja Pavliha)***

NOVE NAJDBE VRSTE *ONTHOPHAGUS FURCATUS* (FABRICIUS, 1781) (COLEOPTERA: SCARABAEIDAE) V SLOVENIJI TER PREGLED NJENE RAZŠIRJENOSTI IN POJAVLJANJA NA SEVEROZAHODNEM BALKANU

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POVZETEK

Rod Onthophagus *obsega 2000 vrst, od tega se jih 40 nahaja v Evropi. V Sloveniji se pojavlja 16 vrst, vendar pet vrst v zadnjih šestdesetih letih ni bilo zabeleženih. Ena od teh je tudi vrsta* Onthophagus furcatus*, ki je razširjena v srednji in južni Evropi, Mali Aziji, Zakavkazju, Arabskem polotoku, Iraku, Turkmenistanu in v Maroku. Najdemo jo na prisojnih pobočjih in suhih pašnikih, kjer se nahaja v konjskih, govejih, človeških in drugih iztrebkih, lahko se zadržuje tudi na mrhovini. V prispevku predstavljamo nove najdbe vrste* O. furcatus *v Sloveniji in s tem potrjujemo njeno prisotnost v južnem delu države, v slovenski Istri. Dodatno predstavljamo prvi pregled pojavljanja te vrste na področju severnega Balkana, ki zavzema Slovenijo, Hrvaško ter Bosno in Hercegovino, vključujoč razširjenost, nadmorsko višino in čas pojavljanja. Na območju severozahodnega Balkana je* O. furcatus *aktiven od aprila do oktobra, predvsem na nadmorskih višinah, nižjih od 400 metrov. Večina najdb izvira iz mediteranskega dela severozahodnega Balkana, medtem ko so podatki s severnega dela redkejši in bolj razpršeni.*

Ključne besede: koprofagni plojkaši, slovenska Istra, višinska razširjenost, časovno pojavljanje

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DELA NAŠIH ZAVODOV IN DRUŠTEV

ATTIVITÀ DEI NOSTRI ISTITUTI E DELLE NOSTRE SOCIETÀ

ACTIVITIES BY OUR INSTITUTIONS AND ASSOCIATIONS

PROF. DR. BOJAN OGORELEC (1945–2013) SLOVENSKI MORSKI GEOLOG

Prof. dr. Bojan Ogorelec (Foto: Arhiv NIB-MBP, GZS)

Julija letos smo se poslovili od kolega in prijatelja prof. dr. Bojana Ogorelca, upokojenega znanstvenega svetnika na Geološkem zavodu Slovenije in izrednega profesorja na Naravoslovnotehniški fakulteti Univerze v Ljubljani ter dolgoletnega glavnega in odgovornega urednika znanstvene revije Geologija. Rodil se je v Celovcu, po zaključenem univerzitetnem šolanju na tedanji Fakulteti za naravoslovje in tehnologijo Univerze v Ljubljani pa se je zaposlil na Geološkem zavodu v Ljubljani, kjer je najprej sodeloval pri nastanku Osnovne geološke karte Jugoslavije. Vseskozi se je zavedal »geološke prostorske omejenosti« slovenskega ozemlja in v težnji po širitvi izobrazbe in izkušenj je že kot študent odšel na prakso v Skandinavijo, kmalu po zaposlitvi na Geološkem zavodu v Ljubljani (1971) pa kot strokovnjak na geološko misijo v Alžirijo. V letih 1973/74 se je izpopolnjeval na prestižni Univerzi v Heidelbergu, kjer je svoje dolgoletno sodelovanje kronal z doktoratom (1988) na temo mikrofaciesa, geokemijskih lastnosti in diageneze dachteinskega apnenca in glavnega dolomita v JZ Sloveniji. Leta 2000 je v zapletenih razmerah prevzel vodenje, najprej kot vršilec dolžnosti, nato pa 2002 kot direktor, Geološkega zavoda Slovenije in ga uspešno vodil do 2006. Nato se je ponovno posvetil vodenju Oddelka za paleontologijo in petrologijo, ki ga je vodil s prekinitvijo v času vodenja zavoda od leta 1975 do upokojitve 2009, in raziskovalne programske skupine »Sedimentologija, mineralogija in petrologija«.

Karbonatne kamnine so bile vseskozi Bojanov osrednji raziskovalni interes in na tem področju se je uveljavil kot utemeljitelj sodobne sedimentologije karbonatnih kamnin v Sloveniji. Tako ni naključje, da so mu raziskave recentnih sedimentov Blejskega in Bohinjskega jezera ter predvsem Tržaškega zaliva omogočile neposreden vpogled v sedimentacijske procese karbonatnih okolij. Z raziskavami Sečoveljskih solin in predvsem recentnega sedimenta Tržaškega zaliva, ki jih je začel pred več kot tridesetimi leti, je tako postal prvi slovenski morski geolog. V njih je izčrpno opisal porazdelitev recentnega sedimenta zaliva na osnovi granulometričnih in mineraloških podatkov ter na osnovi več dolgih vrtin, izvrtanih v Koprskem in Piranskem zalivu, njegov nastanek v holocenu. Kratek, a natančen pregled recentnega sedimenta Tržaškega zaliva v obširni monografiji Geologija Slovenije, katere je bil tudi sourednik, temelji prav na teh izsledkih. Z nadaljnjimi študijami sedimenta celotnega Jadrana pa je potrdil svojo vlogo morskega sedimentologa, ki se uspešno povezuje s strokovnjaki drugih področij (predvsem geokemiki) v multidisciplinarnih raziskavah. Slovenska morska raziskovalna skupnost mu je hvaležna za pomemben prispevek k razvoju področja morske geologije v Sloveniji in upati je, da to pomembno področje, ki ga je začel pokojni B. Ogorelec, ne bo v prihodnosti zamrlo. V plitvem obalnem morju Tržaškega zaliva pa tudi celotnega severnega Jadrana, kjer sta pelagial in bentos pomembno sklopljena, je recentni sediment izrednega pomena in v marsičem uravnava celotne procese. Na koncu in tokrat zares »Ciao, illustro collega«, kot sva se v šali nazivala v pogostih telefonskih razgovorih.

Jadran Faganeli

Odsev dr. B. Ogorelca na predavanju »Sečoveljske soline - geološki laboratorij v naravi: sedimentologija« na mednarodnem znanstvenem sestanku »Sečoveljske soline kot znanstvenoraziskovalni in izobraževalni bazen« 5. oktobra 2012. (Foto: V. Bernetič)

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12. Drugo: latinski izrazi kot npr. *in vivo*, *in situ*, *e.g.*, *i.e.*, ter rodovna (*Myliobatis* sp.) in vrstna (*Myliobatis aquila*) imena se izpišejo v fontu italic. Kadarkoli je možno, se uporabljajo enote iz sistema SI (Système international d'unités).

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7. Il testo principale deve essere strutturato nei seguenti capitoli: Introduzione, Materiali e metodi, Risultati, Discussione o Risultati e discussione, Conclusioni, Ringraziamenti (se necessari), Bibliografia. Il testo può essere strutturato in sottocapitoli (ad es. sottocapitolo Rassegna delle pubblicazioni nell'Introduzione; sottocapitolo Descrizione dell'area di ricerca nel capitolo Materiali e metodi). Le didascalie devono essere presentate separatamente, a seguito del capitolo Bibliografia.

8. Le tabelle saranno preparate in forma elettronica come il manoscritto (formato Word) e allegate in fogli separati alla fine del testo. Gli autori sono pregati di contrassegnare ogni tabella con un numero e il titolo ossia una breve descrizione. Nel testo la tabella viene richiamata come segue: (Tab. 1).

9. Il materiale grafico (grafici, carte geografiche, fotografie, tavole) va preparato in formato elettronico (jpeg o tiff) e consegnato in file separati, con una definizione di 300 dpi alla grandezza desiderata, purché non ecceda i 17x20 cm. Prima della pubblicazione, l'autore provvederà a fornire alla Redazione tutte le autorizzazioni richieste per la riproduzione del materiale grafico (in virtù della Legge sui diritti d'autore). Tutto il materiale grafico deve essere accompagnato da didascalie (vedi punto 7) e numerato.. Nel testo i grafici vengono richiamati come segue: (ad es. Fig. 1).

10. I riferimenti bibliografici (citazioni) richiamano un'altra pubblicazione (articolo). La nota bibliografica, riportata nel testo, deve contenere i seguenti dati tra parentesi: *cognome dell'autore*, *anno di pubblicazione*, ad es. (Novak, 2007). Se gli autori sono due, verranno indicati entrambi (Novak & Kranjc, 2001), nel caso di tre o più autori verrà indicato soltanto il primo, seguito dall'abbreviazione *et al.* (Novak *et al.,* 1999). Vari riferimenti bibliografici in una stessa nota vanno divisi dal punto e virgola e segnalati in ordine cronologico, ad. es. (Novak *et al.*, 1999; Adamič, 2001; Kranjc & Zupan, 2007). La testimonianza (orale, scritta) verrà indicata tra parentesi con l'abbreviazione del nome e con il cognome di chi l'ha trasmessa, seguiti dalla virgola e la dicitura "informazione personale", ad es. (J. Novak, *informazione personale*).

11. La bibliografia completa va inserita in ordine alfabetico nel capitolo Bibliografia. L'autore indicherà esclusivamente i lavori e le edizioni citati nell'articolo. Se si citano più lavori dello stesso autore, verranno indicati prima in ordine cronologico i lavori in cui l'autore appare solo, poi quelli in cui l'autore compare assieme ad un secondo coautore, seguiti infine da quelli in cui egli compare tra più coautori. I nomi delle riviste in cui sono pubblicati i lavori citati saranno indicati nella forma abbreviata (abbreviazioni ufficialmente riconosciute). Gli articoli inediti si possono citare soltanto se sono in corso di pubblicazione, facendo loro seguire la dicitura "in corso di pubblicazione". Gli articoli, non ancora recensiti non possono essere citati.

Esempio di lavoro bibliografico:

Articoli in riviste:

Klock, J.-H., A. Wieland, R. Seifert & W. Michaelis (2007): Extracellular polymeric substances (EPS) from cyanobacterial mats: characterisation and isolation method optimisation. Mar. Biol., 152, 1077-1085.

Libri ed altre pubblicazioni non periodiche (relazioni, tesi di laurea, dissertazioni di dottorato):

Wheeler, A. (1969): The fishes of the British Isles and North-West Europe. McMillan, London, 613 p.

Capitoli di libro:

McEachran, J. D. & C. Capapé (1984): Myliobatidae. In: Whitehead, P. J. P., M. L. Bauchot, J.-C. Hureau, J. Nielsen & E. Tortonese (eds.): Fishes of the North-eastern Atlantic and the Mediterranean, Vol. 1. Unesco, Paris, pp. 205-209.

12. Altro: Le espressioni latine come ad es. *in vivo*, *in situ*, *e.g.*, *i.e.*, i nomi dei generi famiglie (*Myliobatis* sp.) e delle specie (*Myliobatis aquila*) si scrivono con il carattere italic. Quando possibile saranno utilizzate le unità del sistema SI (*Système international d'unités*).

13. Gli autori ricevono le **prime bozze** di stampa per la revisione. Le bozze corrette vanno quindi rispedite entro una settimana alla Redazione. In questa fase, i testi corretti con segni adeguati (indicazioni in merito si trovano alla fine della pubblicazione "Slovenski pravopis" (2001), Ljubljana, ZRC SAZU, 24-25, non possono essere più ampliati. La revisione delle bozze è svolta dalla Redazione.

14. La Redazione rimane a disposizione per eventuali chiarimenti.

LA REDAZIONE

INSTRUCTIONS TO AUTHORS

1. The journal ANNALES (*Annals for Istrian and Mediterranean Studies,* Series historia naturalis) publishes **original scientific** and **review articles** in the field of natural studies related to the specifics of various subfields of Mediterranean natural studies: marine biology and ecology, ichthyology, geology with paleontology, karst studies, olive growing, biodiversity of Slovenia, nature protection, pollution and environmental protection, physical geography of Istria and the Mediterranean, etc. It also publishes **short** scientific papers on completed research projects related to the above-mentioned subfields.

2. The articles submitted can be written in the English, Slovene or Italian language. The authors should ensure that their contributions meet acceptable standards of language, while the editorial board has the right to have them language edited.

3. The articles should be no longer than 48,000 characters (spaces excluded) or 32 typewritten double-spaced pages. They can be submitted via e-mail annales@mbss.org (preferably) or regular mail, with the electronic data carrier (CD) sent to the address of the editorial board.

Submission of the article implies that it reports original unpublished work and that it will not be published elsewhere.

4. The **title page** should include the title of the article, the name and surname of the author(s), their affiliation (institutional name and address) or home address, and e-mail address (of the first author or the corresponding author only).

5. The article should contain the **summary** and the **abstract,** with the former (c. 30 lines) being longer than the latter (c. 10 lines).

The *abstract* contains a brief description of the aim of the article, methods of work and results. It should contain no comments and recommendations.

The *summary* contains the description of the aim of the article and methods of work and a brief analysis or interpretation of results. It can contain only the information that appears in the text as well. It should contain no reference to figures, table and citations published in the main text.

6. Beneath the abstract, the author(s) should supply appropriate **keywords** (max 6) and, if possible, the English (or Slovene) translation of the abstract, summary, keywords, and captions to figures and tables. If unprovided, the translation will be provided by the editorial board.

7. The **main text** should include the following chapters: Introduction, Material and Methods, Results, Discussion or Results and Discussion, Conclusion, Acknowledgement (not obligatory), References. Individual parts of the text can form a sub-chapter (e.g. Survey of Previous Studies under Introduction; Description of Research Area under Material and Methods). Captions to figures should appear on a separate page beneath References.

8. Each **table** should be submitted on a separate page in Word programme (just like the main text). It should be numbered consecutively and supplied with the title – brief description. When referring to the tables in the main text, use the following style: (Tab. 1).

9. Illustrative matter (diagrams, maps, photographs, plates) should be submitted as separate files (in jpeg or tiff format) and saved at a minimum resolution of 300 dpi per size preferred, with the maximum possible publication size being 17x20 cm. Prior to publication, the author(s) should obtain all necessary authorizations (as stipulated by the Copyright and Related Rights Act) for the publication of the illustrative matter and submit them to the editorial board. All figures should be captioned and numbered consecutively (cf. Item 7). When referring to the figures in the main text, use the following style: (Fig. 1).

10. **Bibliographic notes** or **citations** – i.e. references to other articles or publications – should contain the following data: *author* and *year of publication,* e.g. (Novak, 2007). If there are two authors, include both surnames (Novak & Kranjc, 2001); if there are more than two authors, include the surname of the first author followed by a comma and the abbreviation *et al.* (Novak *et al.*, 1999). If there is more than one reference, separate them by a semicolon and list them in ascending chronological order, e.g. (Novak *et al.*, 1999; Adamič, 2001; Kranjc & Zupan, 2007). When citing information obtained through personal communication (oral, written), provide the initial letter of the name and full surname of the informant followed by a comma and the phrase *personal communication,* e.g. (J. Novak, *personal communication*).

11. The entire list of **bibliographic data** should be published under References in alphabetical order. The author(s) should list only the works cited in the article. If you are listing several works by the same author with some of them written in co-authorship, first list those written by the author him/herself, then those written in co-authorship with another author, and finally those written in co-authorship with more than one author, with the entries listed in chronological order. The names of journals in which the works cited were published should be abbreviated (cf. list of official journal abbreviations). Unpublished articles can be cited only if they have been

approved for publication, which should be indicated by adding the phrase *in press* to the end of the relevant bibliography entry.

Some examples of how to cite different types of bibliographical data:

Articles published in serial publications:

Klock, J.-H., A. Wieland, R. Seifert & W. Michaelis (2007): Extracellular polymeric substances (EPS) from cyanobacterial mats: characterisation and isolation method optimisation. Mar. Biol., 152, 1077-1085.

Books and other non-serial publications (reports, diploma theses, doctoral dissertation):

Wheeler, A. (1969): The fishes of the British Isles and North-West Europe. McMillan, London, 613 p.

Chapters published in a book:

McEachran, J. D. & C. Capapé (1984): Myliobatidae. In: Whitehead, P. J. P., M. L. Bauchot, J.-C. Hureau, J. Nielsen & E. Tortonese (eds.): Fishes of the North-eastern Atlantic and the Mediterranean, Vol. 1. Unesco, Paris, pp. 205-209.

12. Miscellaneous: Latin phrases such as *in vivo*, *in situ*, *e.g.*, *i.e.*, and names of genera (*Myliobatis* sp.) and species (*Myliobatis aquila*) should be written in italics. Whenever possible, use the SI units (Système international d'unités).

13. The authors are sent the **first page proofs**. They should be returned to the editorial board within a week. When reading the proofs, the authors should use the correction signs listed at the end of the book Slovenski pravopis (2001), Ljubljana, ZRC SAZU, 24–25.

It is not allowed to lengthen the text during proof-reading. Second proof-reading is done by the editorial board.

14. For additional information regarding article publication contact the editorial board.

EDITORIAL BOARD

KAZALO K SLIKAM NA OVITKU

SLIKA NA NASLOVNICI: Ribe napihovalke (družina Tetraodontidae) so po poreklu tropske ribe, ki pa se v zadnjih desetletjih pojavljajo tudi v Sredozemskem morju. Novembra 2012 se je prva riba napihovalka vrste *Sphoeroides pachygaster* pojavila tudi v slovenskem delu Jadranskega morja. (Foto: B. Furlan)
Sl. 1: Na svetu živi več kot 120 vrst rib napihovalk, ki so tako ime dobile zato, ker ob nevarnosti pred plenilci napolnejo svoj elastični želodec z vodo ali zrakom. (Foto: B. Furlan)
Sl. 2: Rdeča veveričja riba (*Sargocentron rubrum*) se je v Sredozemskem morju pojavila pred več kot desetimi leti, danes pa je v mnogih predelih vzhodnega Sredozemlja že uveljavljena vrsta. (Foto: B. Furlan)
Sl. 3: Lesepska selivka morska flauta (*Fistularia commersoni*) se v Sredozemskem morju tako hitro razširja, da so jo strokovnjaki poimenovali kar lesepski šprinter. (Foto: B. Furlan)
Sl. 4: Mnoge napihovalke imajo izredno lepe živopisane vzorce in so za mnoge podvodne fotografe priljubljen fotografski objekt. (Foto: B. Furlan)
Sl. 5: Kljub izredni strupenosti rib napihovalk in njihovih bližnjih sorodnic jih na Japonskem še vedno uživajo kot ribjo specialiteto »fugu«. (Foto: B. Furlan)
Sl. 6: Konec leta 2013 se je v slovenskem delu Jadranskega morja pojavil napihovalkin bližnji sorodnik afriški kostorog (*Stephanolepis diaspros*), ki je med najuspešnejšimi lesepskimi selivkami. (Foto: B. Furlan)

INDEX TO IMAGES ON THE COVER

FRONT COVER: Pufferfish (family Tetraodontidae) are tropical fishes, which have also been recently found in the Mediterranean Sea. Of late, some species have been recorded in the Adriatic Sea, as well. (Photo: B. Furlan)
Fig. 1: There are more than 120 species of pufferfish in the world. They were named pufferfish because they defend themselves by filling their elastic stomachs with water or air. The photograph shows a juvenile pufferfish specimen of the genus *Arothron* from the waters off Indonesia. (Photo: B. Furlan)
Fig. 2: The redcoat (*Sargocentron rubrum*) was first recorded in the Mediterranean Sea in 2002. Nowadays it is considered to be a rather established species in many areas of the eastern Mediterranean Sea. (Photo: B. Furlan)
Fig. 3: The blue cornetfish (*Fistularia commersoni*) is spreading so rapidly in the Mediterranean Sea that it has been named Lessepsian sprinter by scientists. (Photo: B. Furlan)
Fig. 4: The vivid coloration patterns of pufferfish and their relatives such as this porcupine fish *Diodon holocanthus* from Indonesian waters make them an attractive photographic object for underwater photographers. (Photo: B. Furlan)
Fig. 5: Although the pufferfish and their relatives are known to be among the most poisonous marine organisms, they are still considered a delicacy in Japan, known as “fugu”. The photograph shows a pufferfish *Arothron meleagris* from Indonesian waters. (Photo: B. Furlan)
Fig. 6: By the end of 2013 a pufferfish relative, the reticulated leatherjacket (*Stephanolepis diaspros*), a very successful Lessepsian migrant, was recorded in waters off Slovenia. (Photo: B. Furlan)

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